CHEMISTRY

JEE (MAIN AND ADVANCED) CHEMISTRY

CHEMICAL THERMODYNAMICS

LECTURE SHEET (EXERCISE-I) (LEVEL - I (MAIN) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. An intensive property of theromdynamics means a property which depends

A. On the amount of the substance only

B. On the nature of the substance only

C. Both on the amount as well as nature of the substance

D. Neither on the amount nor on the nature

Answer: B

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2. In which of the following sets, all the properties belong to same category (all extensive or all intensive)

A. Mass, volume, specific heat

B. Temperature, Pressure, Volume

C. Heat capacity, density, entropy

D. Enthalpy, Interval energy, volume

Answer: D

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3. Which is an extensive property of the system?

A. Volume

B. Viscosity

C. Temperature

D. Refractive index

Answer: A

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4. A system which can exchange energy with the surrounding but not matter is called

A. A heterogeneous system

B. An open system

C. A closed system

D. An isolated system

Answer: C

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5. An isolated system is that in which:

A. There is no exchange of energy with the surroundings

B. There is exchange of mass and energy with the surroundings

C. There is no exchange of mass and energy with the surroundings

D. There is exchange of mass with the surroundings

Answer: C

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6. Number of phases present in the following thermodynamic systems are:

(a) $NH_4HS_{(s)} \Leftrightarrow NH_{3(g)} + H_2S_{(g)}$ (b) $CaCO_{3(s)} \Leftrightarrow CaO_{(s)} + CO_{2(g)}$ (c) $N_{2(g)} + 3H_{2(g)} \Leftrightarrow 2NH_{3(g)}$

A. b, c, a

B. c, b, a

C. a, b, c

D. c, a, b

Answer: A

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7. A gaseous system changes from state $A(P_1, V_1, T_1)$ to $B(P_2, V_2, T_2)$, B to $C(P_3, V_3, T_3)$ and finally from C to A. The whole process may be called

A. Reversible process

B. Cyclic process

C. Isobaric process

D. Spontaneous process

Answer: B

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8. If $W = -20kJ$ the negative sign indicates that the

A. expanding system gains work energy and does work on the surroundings

B. expanding system loses work energy and does work on the surroundings

C. expanding system gains work energy and does work on the system

D. expanding system loses work energy and does work by the surroundings

Answer: B

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9. Which of the following statements is correct?

A. Only internal energy is a state function but not work

B. Only work is a state function but not internal energy

C. Both internal energy and work are state functions

D. Neither internal energy nor work is a state function

Answer: A

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10. Assertion(A): Absolute values of internal energy cannot be determined

Reason (R): It is impossible to determine the exact values of constituent energies of the substances

A. A and R are true, R explains A

B. A and R are true, R does not explain A

C. A is true, but R is false

D. A is false, but R is true

Answer: A

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11. The expression $[\Delta E/\Delta T]_V$ represent

A. Heat capacity at constant volume

B. Heat capacity at constant pressure

C. Enthalpy change

D. Entropy change

Answer: A

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12. Assertion (A): Internal energy change in a cyclic process is zero

Reason (R): Internal energy is a state function

A. A and R are true, R explains A

B. A and R are true, R does not explain A

C. A is true, but R is false

D. A is false, but R is true

Answer: A

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13. The enthalpy is maximum for

A. 10gms of water

B. 10gms of ice

C. 10gms of steam

D. same for all

Answer: C

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14. A system absorbs 'xJ' heat and does "yJ" work. Its ΔE is +Ve when

A. $y > x$

B. $x > y$

C. y=2x

D. x=y

Answer: B

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15. A system absorbs 600J of energy and does work equivalent to 400J J of energy. The internal energy changes

A. 1000J

B. 200J

C. 600J

D. 300J

Answer: B

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16. A system absorbs 10kJ of heat at constant volume and its temperature rises from $27^{\circ} C \text{ to} 37^{\circ} C$. The ΔE of reaction is

A. 100kJ

B. 10kJ

C. 0

D. 1kJ

Answer: B

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17. In an adiabatic expansion of ideal gas:

A. $W = -\Delta E$

B. $W = \Delta E$

C. $\Delta E = 0$

D. W=0

Answer: A

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18. An ideal gas occuping a volume of $2dm^3$ and a pressure of 5 bar undergoes isothermal and irreversible expansion against external pressure of 1 bar. The final volume of the system and work involved in the process is

A. $10dm^3, 1000J$

B. $8dm^3, -800J$

C. $10dm^3, -800J$

D. $10m^3, -1000J$

Answer: C

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19. Two moles of an ideal gas is expanded spontaneously into a vacuum. The work done is

A. zero

B. 2J

C. 4J

D. 8J

Answer: A

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20. The total heat content of a system at constant pressure is

A. Enthalpy

B. Interanl energy

C. Entropy

D. Free energy

Answer: A

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LECTURE SHEET (EXERCISE-I) (LEVEL - II (ADVANCED) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. Which has maximum internal energy at 298K?

A. helium gas

B. oxygen gas

C. ozone gas

D. equal

Answer: C

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2. For a gas having molar mass M, specific heat at constant pressure can be given as:

A. $\frac{\gamma R}{M(\gamma - 1)}$

B. $\frac{\gamma}{RM}$

C. $\frac{M}{R(\gamma - 1)}$

D. $\frac{\gamma RM}{\gamma + 1}$

Answer: A

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3. Latent heat of vapourisation of a liquid at 500k and 1atm pressure is 10K. Cal/mole. What is the change in internal energy when 3 moles of the liquid is vapourised at the same temperature

A. 27kCal

B. 7k Cal

C. 33k Cal

D. 25k Cal

Answer: A

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4. Molar heat capacity of water in equilibrium with ice at constant pressure is:

A. zero

B. Infinity (∞)

C. $40.45KJK^{-1}mol^{-1}$

D. $5.48JK^{-1}mol^{-1}$

Answer: B

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5. For polytropic process PV^n = constant, C_m (molar heat capacity) of an ideal gas is given by

A. $C_{v.m}+\frac{R}{(n-1)}$

B. $C_{v,m}+\frac{R}{(1-n)}$

C. $C_{v,m}+R$

D. $C_{p,m}+\frac{R}{(n-1)}$

Answer: B

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LECTURE SHEET (EXERCISE-I) (LEVEL - II (ADVANCED) MORE THAN ONE CORRECT ANSWER TYPE QUESTIONS)

1. The following is/are extensive property/properties

A. internal energy

B. temperature

C. concentration

D. heat capacity

Answer: A::D

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2. If x and Y are two intensive variables then:

A. xy is an intensive variable

B. x/y is an intensive variable

C. (x +y) is an intensive variable

D. dx/dy is an extensive property

Answer: A::B::C

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3. During the isothermal expansion of an ideal gas

A. the internal energy remains unaffected

B. the temperature remains constant

C. the enthalpy remains unaffected

D. the enthalpy becomes zero

Answer: A::B::C

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4. Which of the following is/are true in the case of an adiabatic process

A. q=W

B. $\Delta U = q$

C. q= 0

D. $\Delta U = W$

Answer: C::D

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5. The internal energy of an ideal gas decreases by the same amount as the work done by the system

A. the process must be adiabatic

B. the process must be isothermal

C. the process must be isobaric

D. the temperature must decrease

Answer: A::D

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6. For the adiabatic expansion of an ideal gas

A. PV^{γ}= constant

B. $TV^{\gamma-1} =$ constant

C. $T^{\gamma}P^{1-\gamma}$= constant

D. none of these

Answer: A::B::C

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7. In a process a system does 140j of work on the surroundings and only 40J of heat is added to the system. Hence change in internal energy is

A. 180J

B. $-180J$

C. -23.92 cal

D. $-100J$

Answer: C::D

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8. If a gas absorbs 200J of heat and expands by $500cm^3$ against a constant pressure of $2 \times 10^5 Nm^{-2}$ then change in internal energy is

A. 23.92Cal

B. $-100J$

C. $+100J$

D. $+300J$

Answer: A::C

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9. $1gH_2$ gas at STP is expanded so that volume is doubled. Hence, work done is

A. 22.4L atm

B. 5.6L atm

C. 11.2L atm

D. 1.135KJ

Answer: C::D

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10. 1 mole of an ideal gas A ($C_{v,m} = 3R$) and 2 mole of an ideal gas B are $\left(C_{v.m} = \frac{3}{2}R\right)$ taken in a constainer and expanded reversible and adiabatically from 1 litre of 4 litre starting from initial temperature of 320K. ΔE or ΔU for the process is (in Cal) (Give your answer after divide with 240)

A. $-240R$

B. 240R

C. -1920 Cal

D. $-960R$

Answer: C::D

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11. Two mole of an ideal gas is heated at constant pressure of one atmosphere from $27^{\circ}C$ to $127^{\circ}C$. If $C_{v,m} = 20 + 10^{-2}TJK^{-1}mol^{-1}$, then q and ΔU for the process are respectively.

A. 6362.8J, 4700J

B. 1522.2 Cal, 1124.4 Cal

C. 7062.8 5400J

D. 3181.4J 2350J

Answer: A::B::C

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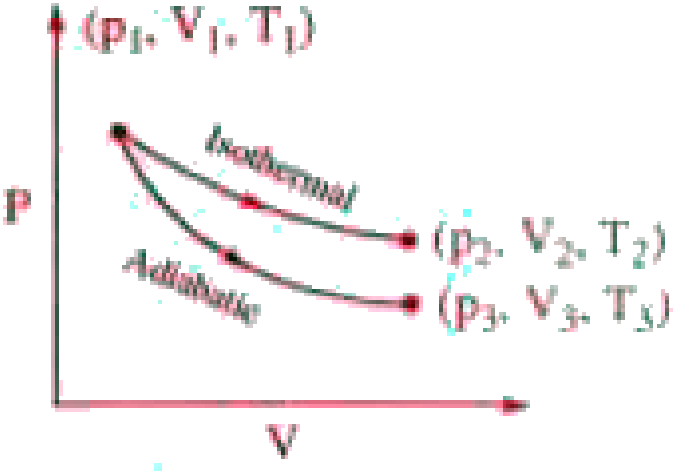
12. The reversible expansion of an ideal gas under adiabatic and isothermal conditions is shown in the figure. Which of the following statements(s) is (are) correct?



A. $T_1 = T_2$

B. $T_3 > T_1$

C. $W_{\text{isothermal}} > W_{\text{adiabatic}}$

D. $\Delta U_{\text{isothermal}} > \Delta U_{\text{adiabatic}}$

Answer: A::C::D

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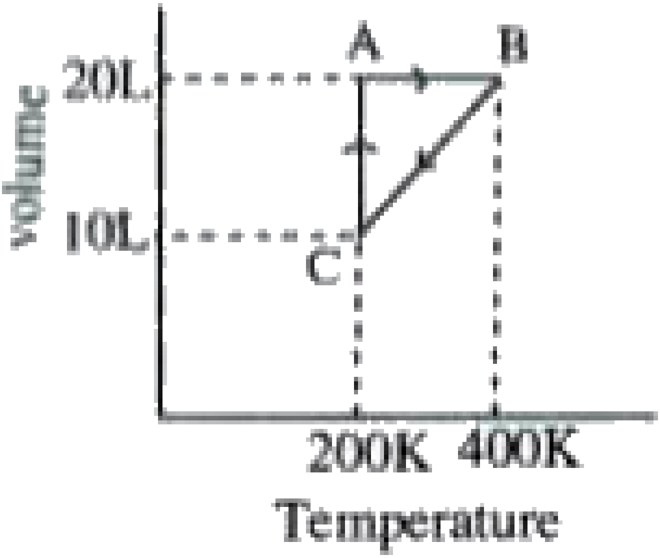
LECTURE SHEET (EXERCISE-I) (LEVEL - II (ADVANCED) LINKED COMPREHENSION TYPE QUESTIONS)

1.



Graph for one moles gas

Process $A \rightarrow B$ represents

A. isobaric

B. isochoric

C. isothermal

D. adiabatic

Answer: B

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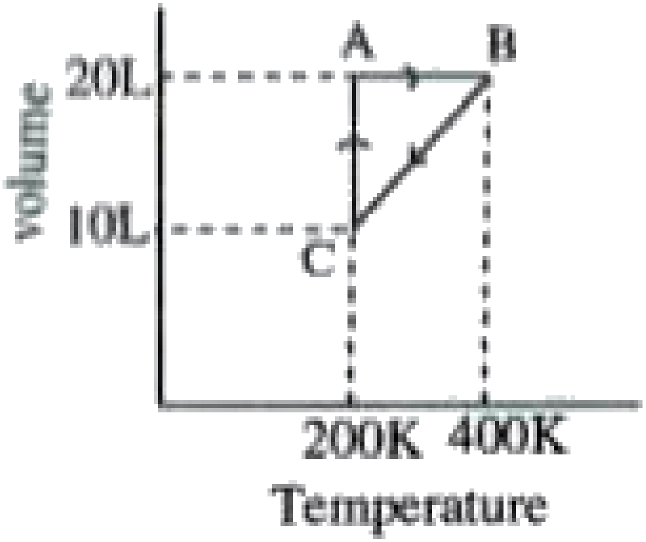

Graph for one moles gas

2.

Work done in the process $C \rightarrow A$ is

A. zero

B. 11.37L atm

C. 22.76L atm

D. unpredictable

Answer: B

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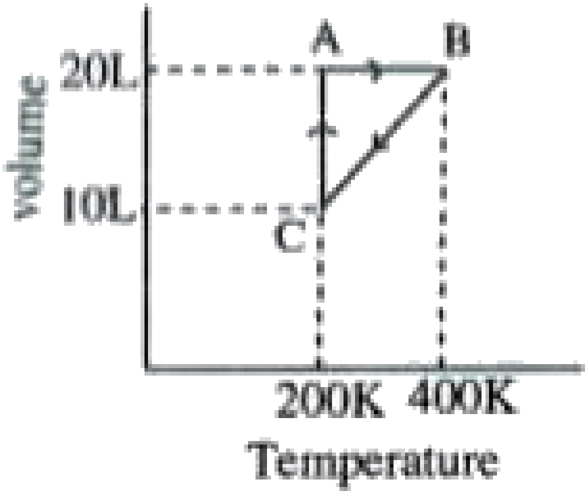
3.



Graph for one moles gas

The process which occurs in going from $B \rightarrow C$ is

A. isothermal

B. adiabatic

C. isobaric

D. isochoric

Answer: C

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4. One mole of an ideal gas for which $C_V = 3/2R$ heated at a constant pressure of 1 atm from $25^0 C to 100^0 C$

What will be the amount of heat change at constant pressure?

A. 223.53 cal

B. 371.25 cal

C. 155.8 Cal

D. 355.68 Cal

Answer: B

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5. One mole of an ideal gas for which $C_V = 3/2R$ heated at a constant pressure of 1 atm from $25^0 C to 100^0 C$

What will be the amount of work done in the process?

A. -62.32 Cal

B. -140.925 Cal

C. -142.27 Cal

D. -148.5 Cal

Answer: D

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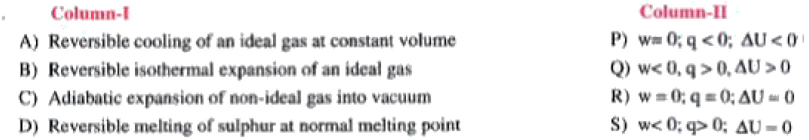
LECTURE SHEET (EXERCISE-I) (LEVEL - II (ADVANCED) MATRIX MATCHING TYPE QUESTIONS)

1. Match the following columns



Column-I	Column-II
A) Reversible cooling of an ideal gas at constant volume	P) $w = 0; q < 0; \Delta U < 0$
B) Reversible isothermal expansion of an ideal gas	Q) $w < 0, q > 0, \Delta U > 0$
C) Adiabatic expansion of non-ideal gas into vacuum	R) $w = 0; q = 0; \Delta U = 0$
D) Reversible melting of sulphur at normal melting point	S) $w < 0; q > 0; \Delta U = 0$

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LECTURE SHEET (EXERCISE-I) (LEVEL - II (ADVANCED) INTEGER TYPE QUESTIONS)

1. Among heat capacity molar heat capacity, molarity, molality, mole fraction, specific heat, the number of extensive properties are?

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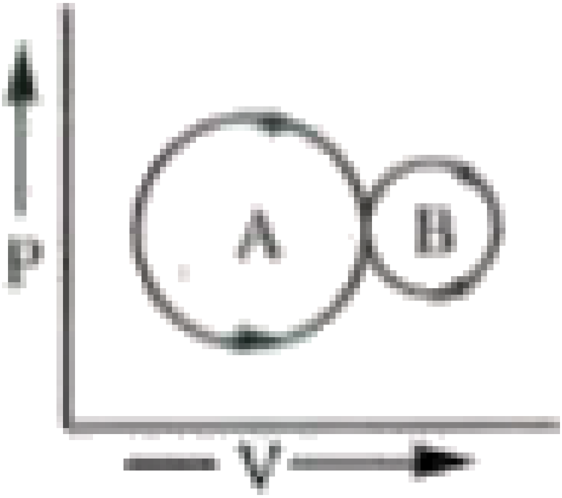
2. In the present graph, the area of circle A and B are 25 unit and 20 unit respectively work done will be 5x, units, x= _____



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3. 1L of NH_3 at $27^\circ C$ is expanded adiabatically to x litres and final temperature is $-123^\circ C$. What is the value of x?

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4. Calculate the work done by the system in an irreversible (sing step) adiabatic expansion of 2 mole of a polyatomic gas $(\gamma = 4/3)$ from 300K and pressure 10atm to 1 atm: (in KJ) (Give your answer after multiplying with 2.08).

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LECTURE SHEET (EXERCISE-II) (LEVEL - I(MAIN) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. When a reaction is conducted in an open vessel, the heat of reaction is represented as

A. ΔH

B. ΔE

C. $P\Delta V$

D. ΔnRT

Answer: A

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2. The factor which does not influence that heat of the reaction is

A. Pressure

B. Temperature

C. Physical state of substance

D. Number of steps involved in the reaction

Answer: D

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3. Assertion(A): The enthalpies of elements in their standard states are taken as zero

Reason (R): It is impossible to determine the absolute enthalpy of any substance

A. A and R are true, R explains A

B. A and R are true, R does not explain A

C. A is true, but R is false

D. A is false, but R is true

Answer: B

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4. The enthalpies of elements under the following conditions are assumed to be

A. zero at 298K and 1 atm

B. Unity at 298K and 1 atm

C. zero at 273K and 1 atm

D. Unity at 273K and 1 atm

Answer: A

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5. For which one of the following systems $DE < DH$

A. $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

B. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

C. $2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$

D. $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$

Answer: C

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6. Which of the following relationships is correct for a reaction involving both reactants and products both in either solid or liquid state?

A. $\Delta H > \Delta E$

B. $\Delta H = \Delta E$

C. $\Delta H < \Delta E$

D. ΔH - $\Delta E = \infty$

Answer: B

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7. For the reaction , $FeCO_{3(s)} \rightarrow FeO_{(s)} + CO_{2(g)}, \Delta H = 82.8 kJ \text{ at } 25^{\circ} C$, what is $(\Delta E \text{ or } \Delta U) \text{ at } 25^{\circ} C$?

A. 82.8kJ

B. 80.32kJ

C. -2394.77 kJ

D. 85.28 kJ

Answer: B

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8. 

LIST-I	LIST-II
A) $H_P > H_R$	1) Exothermic
B) $P\Delta V$	2) Total heat content
C) $E + PV$	3) ΔH is positive
D) $H_R > H_P$	4) Zero at constant volume

The correct is

A. $\begin{array}{cccc} A & B & C & D \\ 3 & 4 & 2 & 1 \end{array}$

B. $\begin{array}{cccc} A & B & C & D \\ 2 & 3 & 1 & 4 \end{array}$

C. $\begin{array}{cccc} A & B & C & D \\ 1 & 3 & 4 & 2 \end{array}$

D. $\begin{array}{cccc} A & B & C & D \\ 1 & 3 & 4 & 2 \end{array}$

Answer: A

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9. Which are of the following is an exothermic reaction?

A. $N_{2(g)} + 3H_{2(g)} - 92KJ \rightarrow 2NH_{3(g)}$

B. $N_{2(g)} + O_{2(g)} + 180.8KJ \rightarrow 2NO_{(g)}$

C. $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{g}\big) \rightarrow 2HCl_{(g)}, \Delta H = -184.6KJ$

D. $C_{(\text{graphite})} + 2H_{2(s)} \rightarrow CH_{4(g)} + 74.8kJ$

Answer: B

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10. The formation of water from $H_{2(g)}$ and $O_{2(g)}$ is an exothermic reaction because

A. $H_{2(g)}$ and $O_{2(g)}$ have a higher chemical energy that water

B. $H_{2(g)}$ and $O_{2(g)}$ have a lower chemical energy that water

C. $H_{2(g)}$ and $O_{2(g)}$ have a higher temperature that water

D. Energy consideration do not arise

Answer: A

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11. The enthalpy of elements in their standard states are taken as zero. Hence the enthalpy of formation of a compound is

A. always negative

B. always positive

C. positive (or) negative

D. equal to zero

Answer: C

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12. Identify the reaction in which the heat liberated corresponds to the heat of formation $\left(\Delta H_f\right)$:

A. $C_{(gra\phi te')} + O_{2(g)} \rightarrow CO_{2(g)} +$ heat

B. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)} +$ heat

C. $C_{(\text{diamond})} + 2H_{2(g)} \rightarrow CH_{4(g)} +$ heat

D. $S_{(\text{rhombic})} + O_{2(g)} \rightarrow SO_{2(g)} +$ heat

Answer: D

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13. In which of the following equations ΔH^0 reaction equal to ΔH_f^0 for the product?

A. $2CO_{2(g)} + O_2 \rightarrow 2CO_2$

B. $N_{2(g)} + O_{3(g)} \rightarrow N_2O_{3(g)}$

C. $CH_{4(g)} + 2Cl_{2(g)} \rightarrow CH_2Cl_{2(l)} + 2HCl_{(g)}$

D. $Xe_{(g)} + 2F_{2(g)} \rightarrow XeF_{4(g)}$

Answer: D

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14. $C_{\text{graphite}} + O_{2(g)} : \Delta H = -393.5kJ. \Delta H$ of the above reaction cannot be

A. Heat of formation of CO_2

B. Heat of combustion of C

C. Heat of reaction

D. Heat of transition

Answer: D

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15. Given that $\frac{1}{2}S_{8(s)} + 6O_{2(g)} \rightarrow 4SO_{3(g)}, \Delta H^0 = -1590kJ.$ The standard enthalpy of formation of SO_3 is

A. $-1590kJmol^{-1}$

B. $-397.5kJmol^{-1}$

C. $-3.975kJmol^{-1}$

D. $+397.5kJmol^{-1}$

Answer: B

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16. ΔH^0 for a reaction $F_2 + 2HCl \rightarrow 2HF + Cl_2$ is given as $-352.8kJ$. ΔH_f^0 for HF is $-268.3KJmol^{-1}$, then ΔH_f^0 of HCl would be

A. $-22kJmol^{-1}$

B. $880kJmol^{-1}$

C. $-91.9kJmol^{-1}$

D. $-183.8 kJmol^{-1}$

Answer: C

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17. The standard enthalpies of formation of $H_2O_{2(l)}$ and $H_2O_{(l)}$ are $-187.8 kJ\text{mole}^{-1}$ and $-285.8 kJ\text{mole}^{-1}$ respectively. The ΔH^0 for the decomposition of one mole of $H_2O_{2(l)}$ to $H_2O_{(l)}$ and $O_{2(g)}$ is

A. $-473.6 kJ.\text{ mole}^{-1}$

B. $-98.9 kJ\text{mole}^{-1}$

C. $+473.6 kJ\text{mole}^{-1}$

D. $+187.8 kJ\text{mole}^{-1}$

Answer: B

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18. The heats of combustion of carbon hydrogen and acetylene are $-394kJ, -286kJ$ and $-1301kJ$ respectively. Calculate heat of formation of C_2H_2

A. 621 kJ

B. 454kJ

C. -227 kJ

D. 227 kJ

Answer: D

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19. Assertion (A): The enthalpy of formation of $H_2O_{(l)}$ is greater than that of $H_2O_{(g)}$

Reason (R): Enthalpy change is negative for the condensation reaction $H_2O_{(g)} \rightarrow H_2O_{(l)}$

A. A and R are true, R explains A

B. A and R are true, R does not explain A

C. A is true, but R is false

D. A is false, but R is true

Answer: A

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20. Work done during the combustion of one mole of CH_4 in bomb calorimeter is

A. zero

B. $-101J$

C. $-24.2J$

D. $-1J$

Answer: A

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21. The heats of combustion of ethane, ethene and acetylene are -341.1 kcal, -330 kcal and -310.9 kCal mol^{-1} respectively. The best fuel among them is

A. Ethane

B. Ethene

C. Acetylene

D. All are equal

Answer: C

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22. The enthalpy change for the process $C_{(\text{graphite})} \rightarrow C(g), \Delta H = +xKJ$ represents enthalpy of

A. Fusion

B. Sublimation

C. Combustion

D. Vapourisation

Answer: B

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23. Enthalpy of neutralisation of all strong acids and strong bases has the same value because

A. Neutralisation leads to the formation of a salt and water

B. Strong acid and bases are ionic substances

C. Acids always furnish H^{+} ions and bases always furnish OH^{-} ions

D. The net chemical change involves the combination of 1 mole of H^{+} ions and 1 mol OH^{-} ions to form water.

Answer: D

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24. $H_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}, \Delta H$ for the above reaction is

A. -13.7 kCal

B. $+57.3$ kCal

C. -27.4 kCal

D. -137 kJ

Answer: C

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25. The enthalpy change for the reaction $C_2H_{6(g)} \rightarrow 2C_{(g)} + 6H_{(g)}$ is x kJ. The bond energy of C-H bond is:

A. $\frac{x}{2}$

B. $\frac{x}{2}$

C. $\frac{x}{6}$

D. data insufficient

Answer: D

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26. The bond dissociation energies for Cl_2, I_2 and Icl are 242.3, 151 and 211.3 kJ/mol respectively. The enthalpy of sublimation of iodine is 62.8 kJ/mol. What is the standard enthalpy of formation of $ICl_{(s)}$?

A. 211.3 kJ/mol

B. 4019Cal/mol

C. 16.8 kJ/mol

D. 33.5 kJ/mol

Answer: B::C

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27. What is the bond enthalpy of Xe-F bond? $XeF_4(g) \rightarrow Xe^+(g) + F^-(g) + F_2(g) + F(g), \Delta_f H = 292$kcal/mol. Given that I.E of Xenon =279k Cal/mole, B.E of $F_2 = 38$ k Cal/mol. E.A of F=85k Cal/mole.

A. 24k Cal/mol

B. 34 k Cal/mol

C. 8.5 k Cal/mol

D. 142.12 k Cal/mol

Answer: B::D

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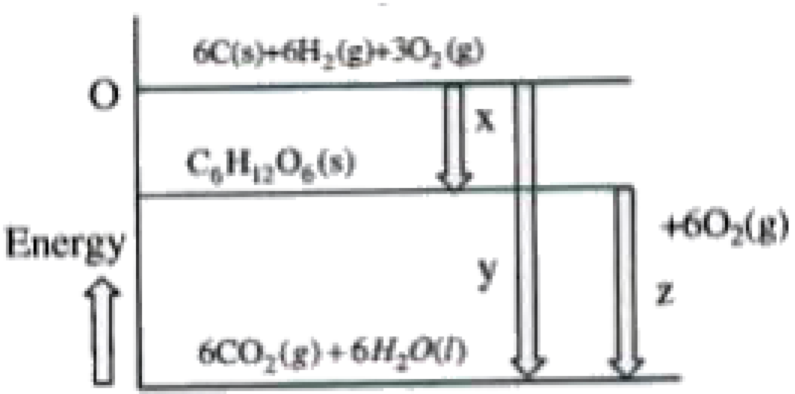
LECTURE SHEET (EXERCISE-II) (LEVEL - I(MAIN) LINKED COMPREHENSION TYPE QUESTIONS)

1. Consdier the following energy level diagram:



The heat of formation of glucose is

A. $-x$

B. $-y$

C. $x-y$

D. $-x+x$

Answer: A

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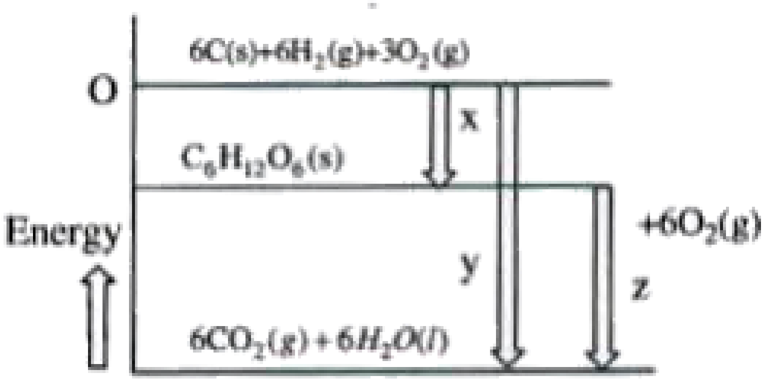
2. Consdier the following energy level diagram:



In the given diagram z refer to

A. $6 \times \Delta H^0_{f\left(CO_2\right)}$

B. $\Delta H^0_{f\left(C_6H_{12}O_6\right)}$

C. $\Delta H^0_{\text{Combustion}}\left(C_6H_{12}O_6\right)$

D. $\Delta H^0_{\text{combustion}}\left(C_6H_{12}O_6\right) + \Delta H^0_{f\left(H_2O_{(l)}\right)}$

Answer: C

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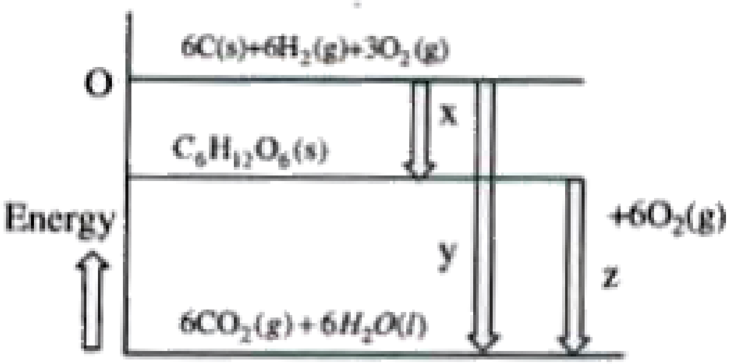
3. Consdier the following energy level diagram:



The quantity y is equal to

A. $\Delta H_{\text{combustion } C(s)} + \Delta H_{\text{combustion} H_2(g)}$

B. $x + z$

C. $x - z$

D. $\Delta H_{fCO_2} + \Delta H_{H_2O}$

Answer: B

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4. Change in enthalpy and change in internal energy are state functions. The value of $\Delta H, \Delta U$ can be determined by using Kirchoff's equation.

Calculate ΔH when $10 dm^3$ of helium at NTP is heated in a cylinder to $100^\circ C$, assuming that the gas behave ideally.

A. 927.9J

B. 279.2J

C. 729.3J

D. 999J

Answer: A

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5. Change in enthalpy and change in internal energy are state functions. The value of $\Delta H, \Delta U$ can be determined by using Kirchoff's equation.

Calculate the heat of formation of methane, given that heat of formation of water $= -286 kJmol^{-1}$, heat of combustion of methane $= -890 kJmol^{-1}$ heat of combustion of carbon $= -393.5 kJmol^{-1}$

A. $90.5 kJmol^{-1}$

B. $-240 kJmol^{-1}$

C. $-75.5 kJmol^{-1}$

D. $95.6 kJmol^{-1}$

Answer: C

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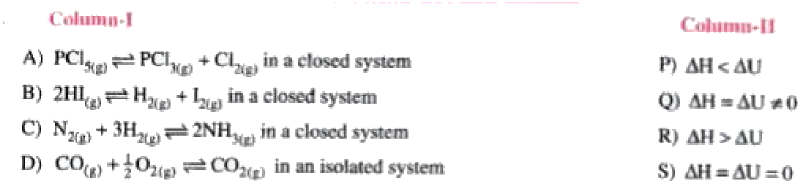
LECTURE SHEET (EXERCISE-II) (LEVEL - I(MAIN) MATRIX MATCHING TYPE QUESTIONS)

1. Match the following columns



Column-I	Column-II
A) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ in a closed system	P) $\Delta H < \Delta U$
B) $2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$ in a closed system	Q) $\Delta H = \Delta U \neq 0$
C) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ in a closed system	R) $\Delta H > \Delta U$
D) $CO_{(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons CO_{2(g)}$ in an isolated system	S) $\Delta H = \Delta U = 0$

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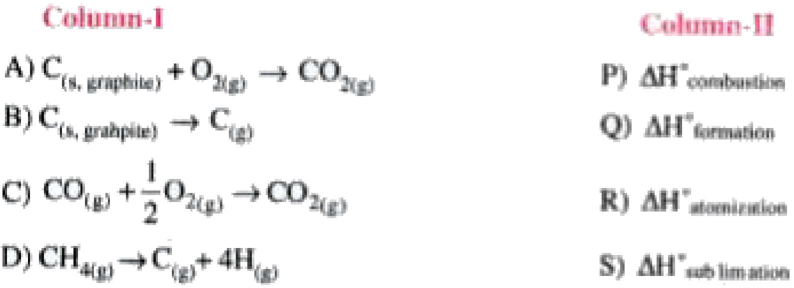
2. Match the following columns



Column-I	Column-II
A) $C_{(s,\ graphite)} + O_{2(g)} \rightarrow CO_{2(g)}$	P) $\Delta H^{\circ}_{combustion}$
B) $C_{(s,\ grahpite)} \rightarrow C_{(g)}$	Q) $\Delta H^{\circ}_{formation}$
C) $CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$	R) $\Delta H^{\circ}_{atomization}$
D) $CH_{4(g)} \rightarrow C_{(g)} + 4H_{(g)}$	S) $\Delta H^{\circ}_{sub\ limation}$

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LECTURE SHEET (EXERCISE-II) (LEVEL - I(MAIN) INTEGER TYPE QUESTIONS)

1. What is the difference between heats of reaction at constant volume and constant pressure for the reaction $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

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2. Heat of combustion of A(s) is $-10 kcal mol^{-1}$ and that of B(s) is -15 Kcal mol^{-1}. Mixture containing 3 moles A(s) and x moles B(s) on combustion released 105 kcal of heat. What is the value of x?

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3. The bond dissociation energies of gaseous H_2, Cl_2 and HCl are 104, 58 and 103 kCal/mole respectively. If magnitude of heat of formation of HCl = 11x, x=?

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4. If $S + O_2 \rightarrow SO_2, \Delta H = -398.5kJ$

$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3, \Delta H = -98.7kJ, SO_3 + H_2O \rightarrow H_2SO_4, \Delta H = -130.5kJ$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O, \Delta H = -227.3kJ$

If magnitude of enthalpy of formation of sulphuric acid at 298K is 95x, x= ?

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5. Heat of neutralisation of a polybasic acid by strong base is -54.8 kcal mol^{-1}. What is basicity of the acid?

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6. 

What is the resonance energy of Benzene in the same units?

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LECTURE SHEET (EXERCISE-III) (LEVEL - I(MAIN) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. 1^{st} law does not tell about

A. Law of conservation of energy

B. Workdone whether +ve (or) -ve

C. Feasibility of a process

D. ΔE at const T

Answer: C

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2. False statement regarding second law of thermodynamics is

A. It is impossible to construct a machine working in cycles which transforms heat from a lower temperature region to higher temperature region without intervention of any external agency

B. Heat cannot flow from a colder body to a hotter body on its own

C. For any spontaneous process taking place in an isolated system $\Delta S < O$

D. All spontaneous processes are thermodynamically irreversible & entropy of the system increases in all spontaneous processes

Answer: C

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3. Entropy of a system depends upon

A. Volume only

B. Temperature only

C. Pressure only

D. Pressure, Volume and temperature

Answer: D

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4. Which one of the following has ΔS^0 greater than zero?

A. $CaO_{(s)} + CO_{2(g)} \Leftrightarrow CaCO_{3(s)}$

B. $NaCl_{(aq)} \Leftrightarrow NaCl_{(s)}$

C. $NaNO_{3(s)} \Leftrightarrow Na^{+}_{(aq)} + NO^{-}_{3(aq)}$

D. $N_{2(g)} + 3H_{2(g)} \Leftrightarrow 2NH_{3(g)}$

Answer: C

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5. Which of the following process has negative value of ΔS?

A. Dissolution of sugar in water

B. Stretching of rubber band

C. Decomposition of lime stone

D. Evaporation of water

Answer: B

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6. For the process Dry ice $\rightarrow CO_{2(g)}$

A. ΔH is positive and ΔS is negative

B. Both ΔH and ΔS are negative

C. Both ΔH and ΔS are positive

D. ΔH is negative and ΔS is positive

Answer: C

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7. $S^0_{H_{2(g)}} = 130.6JK^{-1}mol^{-1}, S^0_{H_2O_{(l)}} = 69.9JK^{-1}mol^{-1}, S^0_{O_{2(g)}} = 205JK^{-1},$

Then the absolute entropy change of $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$ is

A. $-163.2Jmol^{-1}K^{-1}$

B. $+163.2Jmol^{-1}K^{-1}$

C. $-303Jmol^{-1}K^{-1}$

D. $+303Jmol^{-1}K^{-1}$

Answer: A

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8. The direct conversion of A to B is difficult, hence it is carried out by the following shown path $A \rightarrow C \rightarrow D \rightarrow B$. Given $\Delta S_{A \rightarrow C}$= 50 eu, $\Delta S_{C \rightarrow D}$ = 30 eu, $\Delta S_{B \rightarrow D}$= 20eu

A. $+100$ eu

B. $+60$ eu

C. -100 eu

D. -60 eu

Answer: B

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9. Enthalpy of vapourisation for water is 186.5 KJ mole^{-1}. The entropy change during vapourisation is _____ $KJ\text{mole}^{-1}$

A. 0.5

B. 1.0

C. 1.5

D. 2.0

Answer: A

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10. Considering entropy (s) as a thermo dynamic parameter, the criterion for the spontanity of any process is

A. $\Delta S_{\text{sys}} + \Delta S_{\text{surr}} > 0$

B. $\Delta S_{\text{sys') - Delta S\_(}surr} > 0$

C. $\Delta S_{sys'} > 0$ only

D. $\Delta S_{\text{surr}} > 0$ only

Answer: A

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11. $\Delta S_{\text{says}}\text{for}4Fe_{(s)} + 3O_2 \rightarrow 2Fe_2O_{3(s)}$ is - $550 J/k/mol$ at 298K. If enthalpy change for same process is -$1600 kJ/mol$, DS_{total} (in J/mol/K) is

A. $\left[\frac{1600}{298} \times 10^3\right] + 550 > 0$

B. $550 - \left[\frac{1600}{298}\right[< 0$

C. $\left[\frac{1600}{298} \times 10^3\right] - 550 > 0$

D. $\left[\frac{1600 + 550}{298}\right] > 0$

Answer: C

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12. Suppose that a reaction has $\Delta H = -400kJ$ and $\Delta S = -50J/K$. At what temperature range will it change from spontaneous to non-spontaneous?

A. 0.79K to 0.81 K

B. 799 K to 801 K

C. 801 K to 799K

D. 0.81 K to 0.79 K

Answer: B

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13. If an endothermic reaction is non-spontaneous at freezing point of water and becomes feasible at its boiling point, then

A. ΔH is -ve, ΔS is +ve

B. ΔH and ΔS both are +ve

C. ΔH and ΔS both are -ve

D. ΔH is +ve and ΔS is -ve

Answer: B

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14. The favourable conditions for a spontaneous reaction are

A. $T\Delta S > \Delta H, \Delta H = +ve, \Delta S = +ve$

B. $T\Delta S > \Delta H, \Delta H = +ve, \Delta S = -ve$

C. $T\Delta S = \Delta H, \Delta H = +ve, \Delta S = -ve$

D. $T\Delta S = \Delta H, \Delta H = +ve, \Delta S = +ve$

Answer: A

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15. Incorrect statement related to an irreversible process is

A. Entropy of the universe goes on increasing

B. Gibbs energy of the system goes on decreasing

C. Total energy of the universe goes on increasing

D. Total energy of the universe remains constant

Answer: C

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16. The process of evaporation of a liquid is accompanised by

(A) Increase in enthalpy (B) Increase in entropy (C) Decrease in Gibbs energy

The correct statement(s) is/are

A. Only a and c

B. Only b and c

C. Only a and b

D. All

Answer: D

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17. Which of the following is true for a spontaneous process?

A. $\Delta G > 0$

B. $\Delta G < 0$

C. $\Delta G = 0$

D. $\Delta G = T\Delta S$

Answer: B

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18. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}, \Delta H = -ve \text{ and } \Delta G = -ve$ then the reaction is

A. spontaneous and instantaneous

B. Spontaneous and endothermic

C. Spontaneous and slow

D. Non spontaneous and slow

Answer: A

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19. An equilibrium reaction $X + Y \Leftrightarrow W + Z, \Delta H = \ +ve$ is spontaneous in the forward direction. Then corresponding sign of ΔG and ΔS should be respectively

A. $+ve, \ -ve$

B. $-ve, \ +ve$

C. $+ve, \ +ve$

D. $-ve, \ -ve$

Answer: B

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20. 

LIST-I (Melting of Ice)	LIST-II (Condition)
A) Ice at $-10^\circ C$	1) $\Delta G = 0$
B) Ice at $+10^\circ C$	2) $\Delta G = +Ve$
C) Ice at $0^\circ C$	3) $\Delta G = -Ve$

The correct match is

The correct is

A. $\begin{array}{ccc} A & B & C \\ 1 & 2 & 3 \end{array}$

B. $\begin{array}{ccc} A & B & C \\ 3 & 2 & 1 \end{array}$

C. $\begin{array}{ccc} A & B & C \\ 2 & 3 & 1 \end{array}$

D. $\begin{array}{ccc} A & B & C \\ 1 & 3 & 2 \end{array}$

Answer: C

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21. What of the following relationship is correct?

A. $\Delta G^0 = -RT\ln K$

B. $K = e^{-\Delta G^0/RT}$

C. $K = 10^{-\Delta G^0/2.303RT}$

D. All are correct

Answer: D

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22. ΔG^0 for the reaction $x + y \Leftrightarrow z$ is -4.606 kcal. The value of equilibrium constant of the reaction at $227^\circ C$

A. 100

B. 10

C. 2

D. 0.01

Answer: A

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23. (A): Entropy of a perfect crystalline substance at absolute zero is zero

(R): At absolute zero translation kinetic energy of a system is zero.

A. A and R are true, R explains A

B. A and R are true, R does not explain A

C. A is true, but R is false

D. A is false, but R is true

Answer: A

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LECTURE SHEET (EXERCISE-III) (LEVEL - II (ADVANCED) STARAIGHT OBJECTICE TYPE QUESTIONS)

1. What are the sign of the entropy change (+ or -) in the following:

I : A liquid crystallises into a solid

II: Temperature of a crystalline solid is raised from 0K to 115K

III: $2NaHCO_{3(g)} \rightarrow Na_2CO_{3(g)} + CO_{2(g)} + H_2O_{(g)}$

IV : $H_{2(g)} \rightarrow 2H_{(g)}$

A. $\begin{array}{cccc} I & II & III & IV \\ - & + & + & + \end{array}$

B. $\begin{array}{cccc} I & II & III & IV \\ - & - & - & + \end{array}$

C. $\begin{array}{cccc} I & II & III & IV \\ - & - & - & + \end{array}$

D. $\begin{array}{cccc} I & II & III & IV \\ + & - & - & - \end{array}$

Answer: A

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2. Calculate ΔS for 3 moles of a diatomic ideal gas which is heated and compressed from 298K and 1bar to 596K and 4 bar

A. $-14.7 \text{cal} K^{-1}$

B. $+14.7\text{cal}K^{-1}$

C. $-4.9\text{cal}K^{-1}$

D. $6.3\text{cal}K^{-1}$

Answer: D

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3. One mole of an ideal monoatomic gas at $27^\circ C$ is subjected to a reversible isoentropic compression until final temperature reaches $327^\circ C$. If the initial pressure was 1.0 atm then find the value of ln P_2:

A. 1.75

B. 0.176

C. 1.0395

D. 2.0

Answer: A

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4. One mole of an ideal monoatomic gas expands isothermally against constant external pressure of 1 atm from initial volume of 1l to a state where its final pressure becomes equal to external pressure. If initial temperature of gas is 300K then total entropy change of system in the above process is: [R =0.082L atm $mol^{-1}K^{-1} = 8.3Jmol^{-1}K^{-1}$]

A. 0

B. R ln (24.6)

C. R ln (2490)

D. $\frac{3}{2}$ R ln (24.6)

Answer: B

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5. For a perfectly cyrstalline solid $C_{p,m} = aT^3 + bT$, where a and b are constants. If $C_{p,m}$ is 0.40 J/K mol at 10K and 0.92 J/K mol at 20K, then molar entropy at 20K is $0.2x \times R$ joules. Then the value of x is

A. 0.92 J/K mol

B. 8.66 J/K mol

C. 0.813 J/K mol

D. none of these

Answer: C

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6. Calculate standard entropy change in the reaction

$Fe_2O_{3(s)} + 3H_{2(g)} \rightarrow 2Fe_{(s)} + 3H_2O_{(l)}$

Given:

$$S_m^0\left(Fe_2O_3, s\right) = 87.4S_m^0(Fe, s) = 27.3, S_m^0\left(H_2g\right) = 130.7, S_m^0\left(H_2O, 1\right) = 69.9JK$$

A. $-212.5JK^{-1}$

B. $-215.2JK^{-1}mol^{-1}$

C. $-120.9JK^{-1}$

D. none of these

Answer: B

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7. When charcoal burns in air signs of ΔH and $\Delta S$are $2C_{(s)} + O_{2(g)} \rightarrow 2CO_{(g)}$

A. $\begin{matrix} \Delta H & \Delta S \\ + & - \end{matrix}$

B. $\begin{matrix} \Delta H & \Delta S \\ - & + \end{matrix}$

C. $\begin{matrix} \Delta H & \Delta S \\ + & + \end{matrix}$

D. $\begin{matrix} \Delta H & \Delta S \\ - & - \end{matrix}$

Answer: B

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8. For the following process

$H_2O(l)(1 \text{ bar } 373.15K\Big) \Leftrightarrow H_2O(g)$

(1 bar, 373.15 K) identify the correct set of thermodynamic parameters.

A. $\Delta G = 0, \Delta S = \ + ve$

B. $\Delta G = 0, \Delta S = \ - ve$

C. $\Delta G = \ + ve, \Delta S = 0$

D. $\Delta G = \ - ve, \Delta S = \ + ve$

Answer: A

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9. Consider the ΔG_f^0 and ΔH_f^0 (kJ/mol) for the following oxides. Which oxide can be most easily decomposed to form the metal and oxygen gas?

A. $ZnO\left(\Delta G^0 = -318.4, \Delta H^0 = -348.3\right)$

B. $Cu_2O\left(\Delta G^0 = -146.0, \Delta H^0 = -168.8\right)$

C. $HgO\left(\Delta G^0 = -58.5, \Delta H^0 = -90.8\right)$

D. $PbO\left(\Delta G^0 = -187.9, \Delta H^0 = -217.3\right)$

Answer: C

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10. Calculate $\Delta_r G^0$ for $\left(NH_4Cl, s\right)$ at 310K. Given: $D \le ta_f H^0$ for $\left(NH_4Cl, s\right) = -314.5$ KJ/mol, $\Delta_r C_P = 0 S^0_{N_2(g)} = 192 JK^{-1}mol^{-1}, S^0_{H_2(g)} = 130.5 JK^{-1}mol^{-1}, S^0_{Cl_2(g)} = 233 JK^{-}$. All given data at 300K

A. $-198.56 kJ/mol$

B. $-426.7 kJ/mol$

C. $2 - 2.3 kJ/mol$

D. none of these

Answer: A

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11. At $25^{\circ}C, \Delta G^0$ for the process $H_2O_{(l)} \Leftrightarrow H_2O_{(g)}$ is 8.6kJ. The vapour pressure of water at this temperature, is nearly

A. 24 torr

B. 285 torr

C. 32.17 torr

D. 100 torr

Answer: A

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12. Correct statements among the following are

A. The net change in entropy of system is zero in any cyclic process

B. the free energy change of the system at freezing point is zero

C. the change in free energy with pressure for one mole of a perfect gas, $\Delta G = RT\ln\frac{P_2}{P_1}$

D. for a spontaneous change $(\Delta G)_{T,P} > 0$

Answer: A

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LECTURE SHEET (EXERCISE-III) (LEVEL - II (ADVANCED) MORE THAN ONE CORRECT ANSWER TYPE QUESTIONS)

1. All the antural processes in this universe produce

A. a decrease in entropy of the universe

B. an increase in entropy of the universe

C. An increase in entropy of system and surroundings

D. sometimes increase or sometimes decrease in entropy

Answer: B::C

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2. Which of the following conditions is/are favourable for the feasibility of a reaction?

A. $\Delta H = -ve, T\Delta S = +ve$

B. $\Delta H = -ve, T\Delta S = -ve, T\Delta S < \Delta H$

C. $\Delta H = +ve, T\Delta S = +ve, T\Delta S < \Delta H$

D. $\Delta H = +ve, T\Delta S = +ve, T\Delta S > \Delta H$

Answer: A::B::D

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3. Select the correct expressions among the following

A. $\frac{\Delta G - \Delta H}{T} = \left(\frac{\partial \Delta G}{\partial T}\right)_P$

B. $\frac{\Delta G - \Delta H}{T} = \left(\frac{\partial \Delta G}{\partial T}\right)_V$

C. $\frac{\Delta S}{nF} = \left(\frac{\partial E_{\text{cell}}}{\partial T}\right)_P$

D. $\left(\frac{\partial T}{\partial P}\right)_H = \frac{-\left(\frac{\partial H}{\partial P}\right)_T}{C_P}$

Answer: A::C::D

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4. Which of the following conditions are true about spontaneous process?

A. $\left(\Delta G_{\text{system}}\right)_{T.P} < 0$

B. $\Delta S_{\text{system}} + \Delta S_{\text{surr}} > 0$

C. $\left(\Delta G_{\text{system}} - (T, P) = 0\right.$

D. $\Delta S_{\text{system}} + \Delta S_{\text{surr}} < 0$

Answer: A::B

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5. $A \rightarrow B$, Graph between $long_{10}$ P and $\frac{1}{T}$ is a straight line of slope $\frac{1}{4.606}$. Hence, ΔH is

A. 1 cal

B. -4.18 J

C. 4 cal

D. -1 cal

Answer: B::D

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LECTURE SHEET (EXERCISE-III) (LEVEL - II (ADVANCED) LINKED COMPREHENSION TYPE QUESTIONS)

1. As per second law of thermodynamics a process taken place spontaneously if and only if the entropy of the universe increases due to the process. Change in entropy is given by

$$\Delta S = \frac{Q_{rev}}{T}$$

What is the change in entropy of the universe due to the following reaction occuring at $27\,^{\circ}C$?

$A + 2B \rightarrow C + 2D, \Delta H = +1.8 kJmol^{-1}$

Molar entropy values of A, B, C and D are 1,2,3 and $4JK^{-1}mol^{-1}$ respectively.

A. 0

B. $6JK^{-1}mol^{-1}$

C. $8JK^{-1}mol^{-1}$

D. $1.2JK^{-1}mol^{-1}$

Answer: A

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2. As per second law of thermodynamics a process taken place spontaneously if and only if the entropy of the universe increases due to the process. Change in entropy is given by

$$\Delta S = \frac{Q_{rev}}{T}$$

A gas $C_V = (0.2T)CalK^{-1}$. What is the change in its entropy when one mole of it is heated from $27\,^\circ C$ to $127\,^\circ C$ at constant volume ?

A. $20\text{cal } K^{-1}mol^{-1}$

B. $15\text{cal } K^{-1}mol^{-1}$

C. $35\text{cal } K^{-1}mol^{-1}$

D. $25\text{cal } K^{-1}mol^{-1}$

Answer: A

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3. The change in Gibbs free energy of the system along provides a criterion for the spontaneity of a process at constant temperature and pressure. A change in the free energy of a sytem at constant temperature and pressure will be: $\Delta G_{\text{system}} = \Delta H_{\text{system}} - T\Delta S_{\text{system}}$

The free energy for a reaction having $\Delta H = 31400$ cal, $\Delta S = 32$ cal $K^{-1} mol^{-1}$ at $1000\,^{\circ}C$ is

A. -9336 cal

B. -7386 cal

C. -1936 cal

D. $+9336$ cal

Answer: A

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4. For a system in equilibrium Δ G= 0 under conditions of constant:

A. temperature and pressure

B. temperature and volume

C. pressure and volume

D. energy and volume

Answer: A

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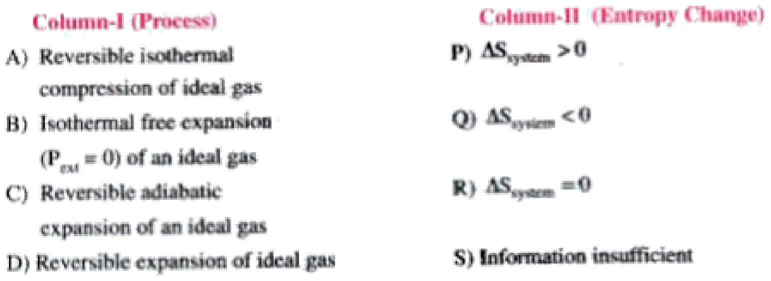
LECTURE SHEET (EXERCISE-III) (LEVEL - II (ADVANCED) MATRIX MATCHING TYPE QUESTIONS)

1.



Column-I (Process)	Column-II (Entropy Change)
A) Reversible isothermal compression of ideal gas	P) $\Delta S_{system} > 0$
B) Isothermal free expansion $(P_{ext} = 0)$ of an ideal gas	Q) $\Delta S_{system} < 0$
C) Reversible adiabatic expansion of an ideal gas	R) $\Delta S_{system} = 0$
D) Reversible expansion of ideal gas	S) Information insufficient

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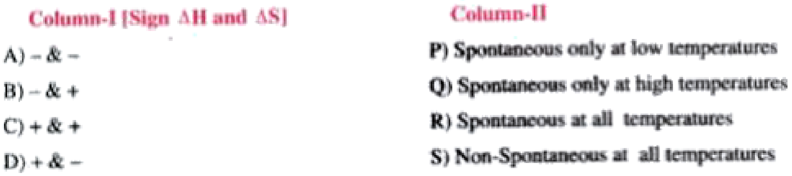
2. Match the following columns



Column-I [Sign ΔH and ΔS]	Column-II
A) – & –	P) Spontaneous only at low temperatures
B) – & +	Q) Spontaneous only at high temperatures
C) + & +	R) Spontaneous at all temperatures
D) + & –	S) Non-Spontaneous at all temperatures

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LECTURE SHEET (EXERCISE-III) (LEVEL - II (ADVANCED) INTEGER TYPE QUESTIONS)

1. In how many of the following entropy increases?

$(a) N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ $(b) PCl_{5(g)} \rightarrow PCl_{3(g)} +$

$(c) H_2O_{(s)} \rightarrow H_2O_{(g)}$ $(d) H_2O_{(l)} \rightarrow H_2O_{(g)}$

$(e) 2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + H_2O_{(g)} + CO_{2(g)}$ $(f) NH_2CO_2NH_{4(s)} \rightarrow 2N$

$(g) H_2O_{(l)} \rightarrow H_2O_{(s)}$ $(h) CO_{2(s)} \rightarrow CO_{2(g)}$

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2. For a liquid, enthalpy of fusion is $1.435 \times 10^3 cal mol^{-1}$ and molar entropy change is $5.26 cal mol^{-1}$. Calculate the melting point of the liquid.

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3. For the reaction, $Ag_2O_{(s)} \Leftrightarrow 2Ag_{(s)} + \frac{1}{2}O_{2(g)} \Delta H, \Delta S$ and T are 40.63 kJ $mol^{-1}, 108.8JK^{-1}mol^{-1}$ and $373K$ respectively. Free energy change ΔG of the reaction will be _____

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4. Calculate the equilibrium constant (in multiples of 10^{-4}) for the reaction $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$ at 400K, if $\Delta H^0 = 77.2KJ\text{mole}^{-1}$ and $\Delta S^0 = 122JK^{-1}\text{mole}^{-1}$

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5. Calculate the free energy change in kJ when 1 mole of NaCl is dissolved in water at 298 K, Given

a) U of NaCl (U = lattice energy) $= 778kJ\text{mole}^{-1}$

b) Hydration energy of NaCl $= -774.3kJmole^{-1}$

(c) Entropy change at 298K = $43mole^{-1}$

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PRACTICE SHEET (EXERCISE- I) (LEVEL- I (MAIN) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. The intensive property among these quantities is

A. Mass

B. Density

C. Enthalpy

D. Volume

Answer: B

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2. Assertion (A): Mass and volume are extensive properties

Reason (R): Mass/volume is also an extensive property

A. A and R are true, R explains A

B. A and R are true, R does not explain A

C. A is true, but R is false

D. A is false, but R is true

Answer: C

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3. A well stoppered thermos flask contains some ice cubes. This is an example of

A. Closed system

B. Open system

C. Isolated system

D. Non-thermodynamic system

Answer: C

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4.

LIST-I	LIST-II
A) Work	1) Extensive property
B) Enthalpy	2) Intensive property
C) Temperature	3) State variable
D) P, V, T and n	4) Path function

The correct match is

The correct match is

A. $\begin{array}{cccc} A & B & C & D \\ 4 & 1 & 2 & 3 \end{array}$

B. $\begin{array}{cccc} A & B & C & D \\ 1 & 2 & 3 & 4 \end{array}$

C. $\begin{array}{cccc} A & B & C & D \\ 4 & 3 & 2 & 1 \end{array}$

D. $\begin{array}{cccc} A & B & C & D \\ 4 & 3 & 1 & 2 \end{array}$

Answer: A

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5. Which of the following statements is false?

A. Work is a state function

B. Temperature is a state function

C. Change of state is completely defined when initial and final states are specified

D. Work appears at the boundary of the system

Answer: A

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6. When freezing of a liquid takes place in a system

A. may have $q > 0$ or $q < 0$ depending on the liquid

B. is represented by $q > 0$

C. is represented by $q < 0$

D. has q = 0

Answer: C

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7. On which of the following factors does internal energy depend upon

A. Mass of the system

B. Temperature of the system

C. Nature of the system

D. All the above

Answer: D

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8. According to IUPAC conventions, which one of the following is/are correct?

A. The heat absorbed by a system is taken as positive

B. If a system is acompained by decrease in energy, ΔE is negative

C. The work done by the system is taken as negative

D. All the above three statements are correct

Answer: D

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9. The heat of reaction at constant volume and temperature is represented by

A. ΔE

B. ΔH

C. ΔP

D. ΔV

Answer: A

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10. During isothermal expansion of an ideal gas, its internal energy

A. Decreases

B. Increases

C. May increase or decrease

D. Remains unchanged

Answer: D

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11. During a process work equivalent to 400J is done on a system, which gives out of 125J of energy. The change in internal energy is

A. 525J

B. 375J

C. 275J

D. 200J

Answer: C

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12. One mole of an ideal gas at 300K is expanded isothermally reversibly from an initial volume of 1 litre to 10 litres. The ΔE for this process is (R = 2 cal $mol^{-1}K^{-1}$)

A. 163.7 cal

B. zero

C. 1381.1 cal

D. 9lit atm

Answer: B

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13. An ideal gas expands in volume from $10^{-3}m^3$ to $10^{-2}m^3$ at 300 K against a constant pressure of 10^5Nm^{-2}. The work done is

A. $-900J$

B. 900kJ

C. 270kJ

D. $-900kJ$

Answer: A

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14. 5 mole of an ideal gas expands isothermally and irreversibly from a pressure of 10 atm to 1 atm against a contant external pressure of 1 atm. W_{irr} at 300K is:

A. $-15.921kJ$

B. $-11.224kJ$

C. $-110.83kJ$

D. none of these

Answer: B

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15. 2 mole of an ideal gas at $27^{\circ}C$ expands isothermally and reversibly from a volume of 4 litre to 40 litre. The work done (in kJ) by the gas is

A. $w = -28.72kJ$

B. $w = -11.488kJ$

C. $w = -5.736kJ$

D. $w = -4.988kJ$

Answer: B

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16. The molar heat capacity of water at constant pressure, C, is $75JK^{-1}mol^{-1}$. When 1.0KJ of heat is supplied to 100g of water which is free to expand, the increase in temperature of water is :

A. 1.2K

B. 2.4K

C. 4.8K

D. 6.6K

Answer: B

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17. Enthalpy "H" can be given as

A. $H = E - PV$

B. $H = E + PV$

C. $H = E + P + V$

D. $H = E - TS$

Answer: B

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PRACTICE SHEET (EXERCISE- I) (LEVEL- II (ADVANCED) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. One mole of an ideal monoatomic gas at temperature T and volume 1L expands to 2L against a constant external pressure of one atm under adiabatic conditions, then final temperature of gas will be:

A. $\frac{T}{2^{2/3}}$

B. $T + \frac{2}{3 \times 0.0821}$

C. T

D. T - $\frac{2}{3 \times 0.0821}$

Answer: D

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2. Which statement(s) is correct,

A. $\left(\frac{\delta H}{\delta T}\right)_P$ - $\left(\frac{\delta U}{\delta T}\right)_V = R$

B. $\left(\frac{\delta H}{\delta T}\right)_P > \left(\frac{\delta U}{\delta T}\right)_V$

C. $\left(\frac{\delta H}{\delta V}\right)_T$ for ideal gas is zero

D. All of these

Answer: D

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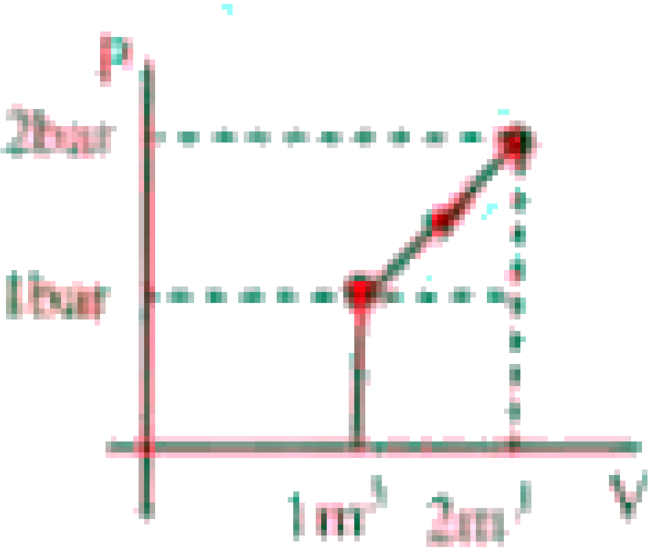
3. What is ΔU for the process described by figure. Heat supplied during the process q= 100kJ



A. $+50kJ$

B. $-50kJ$

C. $-150kJ$

D. $+150kJ$

Answer: B

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PRACTICE SHEET (EXERCISE- I) (LEVEL- II (ADVANCED) MORE THAN ONE CORRECT ANSWER TYPE QUESTIONS)

1. In the isothermal expansion of an ideal gas

A. $\Delta U = 0$

B. $\Delta T = 0$

C. $q = 0$

D. $W = -q$

Answer: A::B::D

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2. Calculate the work done by the system in an irreversible (sing step) adiabatic expansion of 2 mole of a polyatomic gas $(\gamma = 4/3)$ from 300K and pressure 10atm to 1 atm: (in KJ) (Give your answer after multiplying with 2.08).

A. $-227R$

B. -810 Cal

C. $-405R$

D. $-3.367kJ$

Answer: B::C::D

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3. 2 mole of an ideal mono atomic gas undergoes a reversible process for which $PV^2 = C$. The gas is expanded from initial volume of 1L to a final volume of 3L starting from initial temperature of 300K. Find ΔH for the process

A. $-600R$

B. $-1000R$

C. $-3000R$

D. $-2k$ Cal

Answer: B::D

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4. Assuming that, water vapour is an ideal gas the internal energy (ΔU) when 1 mol of water is vapourised at 1 bar pressure and $100^{\circ}C$ (given : molar enthalpy of vaporisation of water at 1 bar and $373K = 41kJmol^{-1}$ and $R = 8.3JK^{-1}mol^{-1}$)) will be

A. $41.00kJmol^{-1}$

B. $4.100kJmol^{-1}$

C. $3,790Jmol^{-1}$

D. $37.9kJmol^{-1}$

Answer: C::D

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PRACTICE SHEET (EXERCISE- I) (LEVEL- II (ADVANCED) LINKED COMPREHENSION TYPE QUESTIONS)

1. If the boundary of system moves by an infinitesimal amount, the work involved is given by $dw = -P_{ext}dV$, for irreversible process $W = -P_{ext}\Delta V$ (where $\Delta V = V_f - V_i$). For reversible process. $P_{ext} = P_{int} \pm dP \cong P_{int}$, so for reversible isothermal process $W = -nRT\text{In}\frac{V_f}{V_i}$

2 mole of an ideal gas undergoes isothermal compression along three different paths:

(i) reversible compression from $P_i = 2$ bar and $V_i = 8L$ to$P_f = 20$ bar

(ii) a single stage compression against a constant external pressure of 20 bar

(iii) a two stage compression consisting initially of compression against a constant external pressure of 10 bar until $P_{gas} = P_{ext}$, followed by compression aganist a constant pressure of 20 bar until $P_{gas} = P_{ext}$

Work done (in bar -L) on the gas in reversible isothermal compression is:

A. 9.212

B. 36.848

C. 18.424

D. none of these

Answer: B

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2. If the boundary of system moves by an infinitesimal amount, the work involved is given by $dw = -P_{\text{ext}} dV$, for irreversible process $W = -P_{\text{ext}}\Delta V$ (where $\Delta V = V_f - V_i$). For reversible process. $P_{\text{ext}} = P_{\text{int}} \pm dP \cong P_{\text{int}}$, so for reversible isothermal process $W = -nRT \text{In} \frac{V_f}{V_i}$

2 mole of an ideal gas undergoes isothermal compression along three different paths:

(i) reversible compression from $P_i = 2$ bar and $V_i = 8L$ to$P_f = 20$ bar

(ii) a single stage compression against a constant external pressure of 20 bar

(iii) a two stage compression consisting initially of compression against a constant external pressure of 10 bar until $P_{gas} = P_{ext}$, followed by compression aganist a constant pressure of 20 bar until $P_{gas} = P_{ext}$

Work done (in bar -L) on the gas in reversible isothermal compression is:

A. 40

B. 80

C. 16

D. none of these

Answer: B

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3. If the boundary of system moves by an infinitesimal amount, the work involved is given by $dw = -P_{ext}dV$, for irreversible process $W = -P_{ext}\Delta V$ (where $\Delta V = V_f - V_i$). For reversible process. $P_{ext} = P_{int} \pm dP \cong P_{int}$, so for reversible isothermal process $W = -nRT\text{In}\frac{V_f}{V_i}$

2 mole of an ideal gas undergoes isothermal compression along three different paths:

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(ii) a single stage compression against a constant external pressure of 20 bar

(iii) a two stage compression consisting initially of compression against a constant external pressure of 10 bar until $P_{\text{gas}} = P_{\text{ext}}$, followed by compression aganist a constant pressure of 20 bar until $P_{\text{gas}} = P_{\text{ext}}$

Order of magnitude work is

A. $w_1 > w_2 > w_3$

B. $w_3 > w_2 > w_1$

C. $w_2 > w_3 > w_1$

D. $w_1 = w_2 = w_3$

Answer: C

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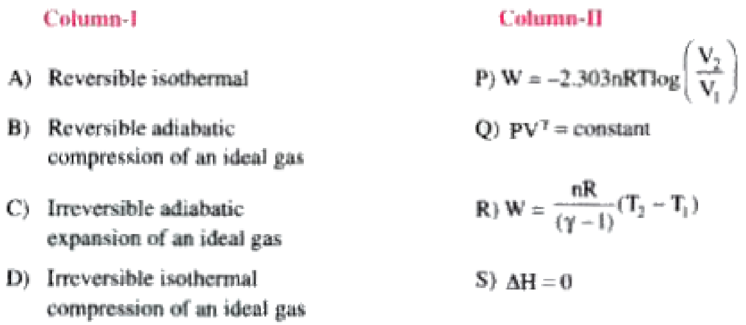
PRACTICE SHEET (EXERCISE- I) (LEVEL- II (ADVANCED) MATRIX MATCHING TYPE QUESTIONS)

1. Match the following columns



Column-I	Column-II
A) Reversible isothermal	P) $W = -2.303nRT\log\left(\frac{V_2}{V_1}\right)$
B) Reversible adiabatic compression of an ideal gas	Q) $PV^{\gamma} = \text{constant}$
C) Irreversible adiabatic expansion of an ideal gas	R) $W = \frac{nR}{(\gamma - 1)}(T_2 - T_1)$
D) Irreversible isothermal compression of an ideal gas	S) $\Delta H = 0$

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2. Match the following columns

Column-I	Column-II
A) $W_{rev} < W_{irr}$	P) Isothermal expansion
B) $W_{rev} > W_{irr}$	Q) Isothermal compression
C) $T_f < T_i$	R) Adiabatic expansion
D) $T_f > T_i$	S) Adiabatic compression

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PRACTICE SHEET (EXERCISE- I) (LEVEL- II (ADVANCED) INTEGER TYPE QUESTIONS)

1. Gas $\left(A_x\right)$ has the ratio of molar specific heats equal to 1.66. The value of x will be _____

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2. 4.48 L of an ideal gas at STP requires 12 cal to raise the temperature by $15^0 C$ at constant volume. The C_P of the gas is ____ cal

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3. 10 grams of argon gas is compressed isothermally and reversibly at a temperature of $27\,^\circ C$ from 10L to 5L. Calculate the work done for this process in multiple of 10^{20} calories.

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4. Calculate the maximum work done (in multiple of 10^3) in expanding 16g of oxygen at 300K and occupying a volume of $5dm^3$ isothermally, until the voume becomes $25dm^3$ (Give you anwer as nearest integer)

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5. Calculate the ΔH for the isothermal reversible expansion of 1 mole of an ideal gas from initial pressure of 1.0 bar to a final pressure 0.1 bar at a constant temperature at 273K.

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PRACTICE SHEET (EXERCISE- II) (LEVEL- I (MAIN) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. When a solid melts there is

A. An increase in enthalpy

B. A decrease in enthalpy

C. No change in enthalpy

D. A decrease in internal energy

Answer: A

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2. For $N_2 + 3H_2 \rightarrow 2NH_3$, enthalpy and internal energy changes respectively are, ΔH & ΔU then

A. ΔH - 0

B. $\Delta H \neq \Delta U$

C. $\Delta H < \Delta U$

D. $\Delta H > \Delta U$

Answer: C

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3. For which of the following reaction $\Delta H = \Delta E + 2RT$

A. $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

B. $NH_4HS_{(s)} \rightarrow NH_{3(g)} + H_2S_{(g)}$

C. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

D. $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

Answer: B

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4. Which of the indicated relationship is correct for the following exothermic reaction carried out at constant pressure? $CO_{(g)} + 3H_{2(g)} \rightarrow CH_{4(g)} + H_2O_{(g)}$

A. $\Delta E = \Delta H$

B. $\Delta E > \Delta H$

C. $W < 0$

D. $q > 0$

Answer: B

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5. For which of the following elements, the standard enthalpy is not zero?

A. C(Diamond)

B. C(Graphite)

C. Liquid mercury

D. Rhombic sulphur

Answer: A

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6. Which are of the following is an exothermic reaction?

A. $N_{2(g)} + O_{2(g)} + 180.8k.J \rightarrow 2NO_{(g)}$

B. $N_{2(g)} + 3H_{2(g)} - 92k.J \rightarrow 2NH_{3(g)}$

C. $C_{(\text{graphite})} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)} - 131.3kJ$

D. $C_{(\text{graphite})} + 2S_{(s)} \rightarrow CS_{2(l)} - 91.9kJ$

Answer: B

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7. (A) : The reaction $C + O_2 \rightarrow CO_2$ is an exothermic reaction

Reason (R): In this reaction that total enthalpy of the product is less than the total enthalpy of the reactants

A. A and R are true, R explains A

B. A and R are true, R does not explain A

C. A is true, but R is false

D. A is false, but R is true

Answer: A

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8. For the transition $C_{(\text{diamonid})} \rightarrow C_{(\text{graphite})}, \Delta H = -1.5 KJ$. It follows that

A. Graphite is stable than diamond

B. Diamond is stable than graphite

C. Graphite is an endothermic substance

D. Diamond is an exothermic substance

Answer: A

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9. Which of the following equation represents standard heat of formation of ethanol?

A. $CH_3CHO_{(l)} + \frac{1}{2}H_{2(g)} \xrightarrow{Ni} C_2H_5OH_{(l)}$

B. $2C_{\text{graphite}} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(g)}$

C. $2C_{\text{diamond}} + 3h_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(g)}$

D. $2C_{\text{graphite}} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(l)}$

Answer: D

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10. Which of the following is not a combustion reaction

A. $CO + \frac{1}{2}O_2 \rightarrow CO_2$

B. $C + O_2 \rightarrow CO_2$

C. $C + \frac{1}{2}O_2 \rightarrow CO$

D. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Answer: C

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11. The chemical process involved in the combustion reactions is

A. Oxidation

B. Reduction

C. Redox reaction

D. Disproportionation reaction

Answer: C

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12. $MgSO_{4(s)} + H_2O \rightarrow MgSO_{4(aq)}, \Delta H = -84K$. Cals, ΔH of the reaction is known as

A. Heat of dilution

B. Heat of solution

C. Heat of fusion

D. Heat of transition

Answer: B

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13. The heat change for the following reaction $C_{(s)} + 2S_{(s)} \rightarrow CS_{2(l)}$ is known as

A. Heat of formation of CS_2

B. Heat of fusion of CS_2

C. Heat of vapourisation of CS_2

D. Heat of transition of carbon

Answer: A

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14. $N_2 + 3H_2 \rightarrow 2NH_3, \Delta H = -46K$. Cals. From the above reaction, heat of formation of ammonia is

A. 46k Cals

B. -46 kCals

C. -23 kCals

D. 23kCals

Answer: C

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15. The enthalpies of HCl, NaOH ,NaCl and H_2O are $-120, -82, -148$ and -68 kCals. Respectively. ΔH of the following reaction is $HCl + NaOH \rightarrow NaCl + H_2O$

A. -28.7 kCals

B. -18 kCals

C. -57.3 kCals

D. -14 kCals

Answer: D

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16. How much energy is released when 6 mole of octane is burnt in air? Given ΔH_f^0 for $CO_{2(g)}, H_2O_{(g)}$ and $C_8H_{18(l)}$ respectively are $-390, \ -240$ and $+160$ KJ/mol

A. $-32.6MJ$

B. $-37.4MJ$

C. $-35.5MJ$

D. $-20.00MJ$

Answer: A

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17. What is theheat of formation of C_6H_6, given that the heats of combustion of benzene, carbon and hydrogen are 782, 94 and 68K. Cal respectively

A. $+14$ kCal

B. -14 kCal

C. $+28$ kCal

D. -28 kCal

Answer: A

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18. Heat of combustion of C_2H_4 is -337 kCal. If 5.6 lit O_2 is used at STP, in the combustion heat liberated is _____ kCal

A. 28.08

B. 14.04

C. 42.06

D. 56.16

Answer: A

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19. For the following reaction $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}, \Delta H = -Q$, where ΔH represents

A. Heat of formation

B. Heat of combustion

C. Heat of neutralisation

D. Heat of dilution

Answer: C

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20. For the reaction $2H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$, the value of ΔH is

A. 114.6 kJ

B. $-114.6kJ$

C. 57.3kJ

D. $-57.3kJ$

Answer: C

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21. The heat of neutralisation is maximum when

A. Sodium hydroxide is neutralised by acetic acid

B. Ammonium hydroxide is neutralised by acetic acid

C. Ammonium hydroxide is neutralized by hydrochloric acid

D. Sodium hydroxide is neutralized by hydrochloric acid

Answer: D

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22. Assertion (A): Heat of neutralization of $HClO_4$ with NaOH is same as that of HCl with NaOH

Reason (R): Both HCL and $HClO_4$ are strong acids

A. A and R are true, R explains A

B. A and R are true, R does not explain A

C. A is true, but R is false

D. A is false, but R is true

Answer: A

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23. In which of the following combinatins of HCL and NaOH, the heat energy liberated is maximum

A. 10ml of 0.1m HCl + 40 ml of 0.1 M NaOH

B. 30 ml of 0.1M HCl + 20 ml of 0.1 M NaOH

C. 25ml of 0.1M HCl + 25 ml of 0.1 M NaOH

D. 35ml of 0.1M HCl+ 15 ml of 0.1 M NaOH

Answer: C

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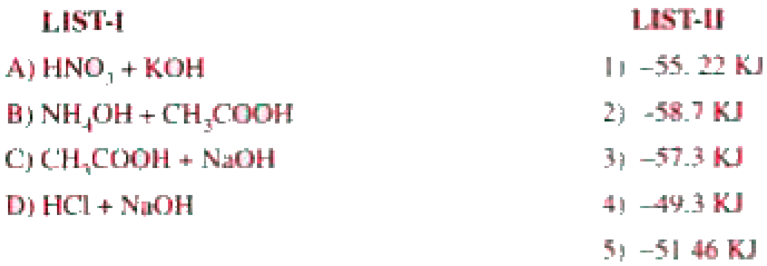
24.



LIST-I	LIST-II
A) $HNO_3 + KOH$	1) −55. 22 KJ
B) $NH_4OH + CH_3COOH$	2) -58.7 KJ
C) $CH_3COOH + NaOH$	3) −57.3 KJ
D) $HCl + NaOH$	4) −49.3 KJ
	5) −51 46 KJ

The correct match is

A. $\begin{array}{cccc} A & B & C & D \\ 1 & 2 & 3 & 4 \end{array}$

B. $\begin{array}{cccc} A & B & C & D \\ 4 & 3 & 2 & 1 \end{array}$

C. $\begin{array}{cccc} A & B & C & D \\ 3 & 4 & 1 & 3 \end{array}$

D. $\begin{array}{cccc} A & B & C & D \\ 3 & 2 & 1 & 4 \end{array}$

Answer: C

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25. Heat of neutralisation for the reaction $NaOH + HCl \rightarrow NaCl + H_2O$ is $-57.1 kJ \text{mole}^{-1}$. The heat relased when 0.25 moles of NaOH is treated with 0.25 moles of HCl is

A. 22.5kJ

B. 57.1kJ

C. 14.3kJ

D. 28.6 kJ

Answer: C

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26. Under the same conditions how many mL of 1M KOH and 0.5M H_2SO_4 solutions, respctively when mixed for a total volume of 100mL produce the highest rise in temperature

A. $67:33$

B. $33:67$

C. $40:60$

D. $50:50$

Answer: D

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27. Given that the data for neutralization of a weak acid (HA) and strong acid with a strong base is:

$HA + OH^- \Rightarrow A^- + H_2O : \Delta H = -41.80kJ, H^+ + OH^- \Rightarrow H_2O, \Delta H = -55.90kJ$

The enthalpy of dissociation of weak acid would be

A. $-97.20kJ$

B. $+97.70kJ$

C. $-14.10kJ$

D. $14.10kJ$

Answer: D

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28. The standard heat of formation of sodium ions in aqueous solution from the following data :

Heat of formation of $NaOH(aq)$ at $25^{\circ}C = -470.7KJ$:

Heat of formation of OH^{-1} at $25^{\circ}C = -228.8KJ$ is :

A. $-251.9KJ$

B. 241.9KJ

C. $-241.9KJ$

D. $300KJmol^{-1}$

Answer: C

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29. Heat released in neutralisation of 1 mole of HF with excess NaoH is

A. 57.32kJ

B. $> 57.32kJ$

C. $< 57.32 kJ$

D. none of these

Answer: B

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30. Hess's law states that

A. The standard enthalpy of an overall reaction is the sum of the enthalpy changes in individual reactions

B. enthalpy of formation of a compound is same as the enthalpy of decomposition of the compound into constituent elements, but with opposite sign

C. at constant temperature the pressure of a gas is inversely proportional to its volume

D. the mass of a gas dissolved per lit of a solvent is proportional to the pressure of the gas in equilibrium with the solution

Answer: A

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31. Given $C + 2S \rightarrow CS_2, \Delta Hf^0 = +117.0KJmol^{-1}, C + O_2 \rightarrow CO_2, \Delta Hf^0 = -393.0KJmol$

. The heat of combustion of $CS_2 + 3O_2 \rightarrow CO_2 + 2SO_2$ is

A. $-807KJmol^{-1}$

B. $-1104KJmol^{-1}$

C. $+1104KJmol^{-1}$

D. $+807KJmol^{-1}$

Answer: B

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32. $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O, \Delta H =$ - 13.6 Kcal. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O, \Delta H =$ - 68 Kcal. What is hat of formation of OH^- ?

A. -54.4 kCal

B. +54.4 kCal

C. +13.6 kCal

D. -13.6 kCal

Answer: A

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33. $N_{2(g)} + 2O_{2(g)} \rightarrow 2NO_2 + xkJ, 2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)} + ykJ.$

The enthalpy of formation of NO is

A. $(2x - 2y)$

B. $x - y$

C. $1/2(y - x)$

D. $1/2(x - y)$

Answer: C

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34. $\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightarrow HCl_{(g)}, \Delta H^0 = -92.4$ kJ/mole, $HCl_{(g)} + nH_2O \rightarrow H^+_{(aq)} + Cl^-_{(aq)}, \Delta H^0 = -74.8$ kJ/mole $\Delta H^0 f$ for $Cl^-_{(aq)}$ is

A. -17.6 kJ/mole

B. -167.2 kJ/mole

C. $+17.6$ kJ/mole

D. -35.2 kJ/mole

Answer: B

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35. The heat of atomisation of $PH_{3(g)}$ is 228 kCal mol^{-1} and that of $P_2H_{2(g)}$ is 355 kCal mol^{-1}. The energy of the P-P bond is (kn kCal)

A. 102

B. 51

C. 26

D. 204

Answer: B

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36. The enthalpy change for the following reaction is 368kJ. Calculate the average O-F bond energy. $OF_{2(g)} \rightarrow O_{(g)} + 2F_{(g)}$

A. 184 kJ/mol

B. 368 kJ/mol

C. 536 kJ/mol

D. 736 kJ/mol

Answer: A

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PRACTICE SHEET (EXERCISE- II) (LEVEL- II (ADVANCED) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. For the real gases reaction $2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}, \Delta H = -560kJ.$ In a 10L rigid vessel at 500K, the initial pressure is 70 bar and after reaction it becomes 40 bar. The change in internal energy is:

A. $-557kJ$

B. $-530kJ$

C. $-563kJ$

D. none of these

Answer: B

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2. A sample of CH_4 of 0.08g was subjected to combustion at $27^\circ C$ in a bomb calorimeter. The temperature of the calorimeter system was found to be raised by $0.25^\circ C$. If heat capacity of calorimeter is $18kJ/^\circ C$, ΔH for combustion of CH_4 at $27^\circ C$ is

A. -900 kJ/mole

B. -905 kJ/mole

C. -895 kJ/mole

D. -890 kJ/mole

Answer: B

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3. Heat liberated in the neutralisation of 500 ml of 1N HCl and 500ml of 1N NH_4OH is -1.36 K.Cals. The heat of ionisation of NH_4OH is

A. 10.98 kCals

B. -12.34 kCals

C. -10.98 kCals

D. 12.34 kCals

Answer: A

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4. Based on the values of B.E. given, $\Delta_f H^0$ of $N_2H_{4(g)}$ is : Given BE of : $N-N$ is 159 kJ mol^{-1}, H-H is 436 kJ mol^{-1}, $N = -N$ is 941 kJ mol^{-1}, $N-H$ is 398 kJ mol^{-1}

A. $711 kJ mol^{-1}$

B. $62 kJ mol^{-1}$

C. $-98kJmol^{-1}$

D. $-711kJmol^{-1}$

Answer: B

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PRACTICE SHEET (EXERCISE- II) (LEVEL- II (ADVANCED) MORE THAN ONCE CORRECT ANSWER TYPE QUESTIONS)

1. The value of $\Delta H - \Delta U$ for the following reaction at $27^{\circ}C$ will be :

$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

A. $8.314 \times 273 \times (-2)J$

B. $8.314 \times 300 \times (-2)J$

C. $-600R$

D. $8.314 \times 300 \times 2J$

Answer: B::C

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2. Which of the following reactions have same heat of reaction at constant pressure and at constant volume?

A. $H_{2(g)} + Cl_{2(g)} \Leftrightarrow 2HCl_{(g)}$

B. $2NO_{(g)} \Leftrightarrow N_{2(g)} + O_{2(g)}$

C. $Co_3O_{4(s)} + 4CO_{(g)} \Leftrightarrow 3Co_{(s)} + 4CO_{2(g)}$

D. $N_{2(g)} + 3H_{2(g)} \Leftrightarrow 2NH_{3(g)}$

Answer: A::B::C

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3. For the reaction $2H_{2(g)} + o_{2(g)} \rightarrow 2H_2O_{(g)}, \Delta H^\circ = -573.2kJ$. The heat of decomposition of water per mol is:

A. 286.6kJ

B. 573.2 kJ

C. -28.66 k Cal

D. 68.56 kCal

Answer: A::D

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4. The amount of heat released, when 20 ml of 0.5 M NaOH is mixed with 100 mL of 0.1M HCl, is x k cal. The heat of neutralisation is

A. $10xk \text{ Cal mole}^{-1}$

B. $100xk \text{ Cal mole}^{-1}$

C. $-100xk \text{ Cal mole}^{-1}$

D. $-23.92xk \text{ Cal mole}^{-1}$

Answer: C::D

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5. When 1.0g of oxalic acid $\left(H_2C_2O_4\right)$ is burned in a bomb calorimeter whose heat capacity is 8.75kJ/K, the temperature increases by 0.312K. The enthalpy of combustion of oxalic acid at $27\,^\circ C$

A. -245.7 kJ/mol

B. 249.4 kJ/mol

C. -241.9 kJ/mol

D. -57.87 k Cal mol^{-1}

Answer: C::D

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6. Consider the following data:

$\Delta_f H^2\left(N_2H_4, l\right) = 50 kJ/mol, , \Delta_f H^\circ\left(NH_3, g\right) = -46 kJ/mol,$ B.E. $(N-H) = 393 kJ/mol$ and $B.E.(H-H) =$ 436 kJ/mol, also $\Delta_{\text{vap}} H\left(N_2H_4, l\right) = 18 kJ/mol$. The N-N bond energy in N_2H_4 is

A. 226 kJ/mol

B. 154 kJ/mol

C. 190 kJ/mol

D. 45.45 k Cal/mole

Answer: C::D

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PRACTICE SHEET (EXERCISE- II) (LEVEL- II (ADVANCED) LINKED COMPREHENSION TYPE QUESTIONS)

1. Enthalpy of neutralization is defined as the enthalpy change when 1 mole of acid/base is completely neutralized by base/acid in dilute solution. For strong acid and strong base neutralization net chemical change is $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}, \Delta H^0_r \equiv -55.84 kJ/mol$

If enthalpy of neutralization of CH_3COOH by NaoH is -49.86 kJ/mol then enthalpy of ionisation of CH_3COOH is

A. 5.98 kJ/mol

B. -5.98 kJ/mol

C. 105.7 kJ/mol

D. none of these

Answer: A

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2. Enthalpy of neutralization is defined as the enthalpy change when 1 mole of acid/base is completely neutralized by base/acid in dilute solution. For strong acid and strong base neutralization net chemical change is $H^{+}_{(aq)} + OH^{-}_{(aq)} \rightarrow H_2O_{(l)}, \Delta H^0_r \equiv -55.84kJ/mol$

What is ΔH^0 for complete neutralisation of strong diacidic base $A(OH)_2$ by HNO_3?

A. $-55.84kJ$

B. $-111.68kJ$

C. 55.84 kJ/mol

D. none of these

Answer: B

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3. Enthalpy of neutralization is defined as the enthalpy change when 1 mole of acid/base is completely neutralized by base/acid in dilute solution. For strong acid and strong base neutralization net chemical change is $H^{+}_{(aq)} + OH^{-}_{(aq)} \rightarrow H_2O_{(l)}, \Delta H^{0}_{r} \equiv -55.84 kJ/mol$

Under the same conditions how many mL of 0.1M NaOH and 0.05 M H_2A (strong diprotic acid) should be mixed for a total volume of 100mL to produce the highest rise in temperature:

A. $25 : 75$

B. $50 : 50$

C. $75 : 25$

D. $66.66 : 33.33$

Answer: B

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4. The bond dissociation energy depends upon the nature of the bond and nature of the molecule. If any molecule more than 1 bonds of similar nature are present then the bond energy reported is the average bond energy.

Determine $C - C$ and $C - H$ bond enthalpy (in kJ/mol). Given: $\Delta_f H^0\left(C_2H_6, g\right) = -85kJ/mol, \Delta_f H^0\left(C_3H_8, g\right) = -104kJ/mo \le , \Delta_{sub}H^0(C, s) =$

, B.E. (H-H)= 436 kJ/mol,

A. 414345

B. 345414

C. 287405.5

D. none of these

Answer: B

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5. The bond dissociation energy depends upon the nature of the bond and nature of the molecule. If any molecule more than 1 bonds of similar nature are present then the bond energy reported is the average bond energy.

If enthalpy of hydrogenation of $C_6H_{6(l)}\text{into}C_6H_{12(l)}$ is $-205kJ$ and resonance energy of $C_6H_{6(l)}$ is $-152kJ/mol$ then enthalpy of hydrogenation of

is ? Answer

ΔH_{vap} of $C_6H_{6(l)}, C_6H_{10(l)}, C_6H_{12(l)}$ all are equal:

A. -535.5 kJ/mol

B. -238 kJ/mol

C. -357 kJ/mol

D. -119 kJ/mol

Answer: D

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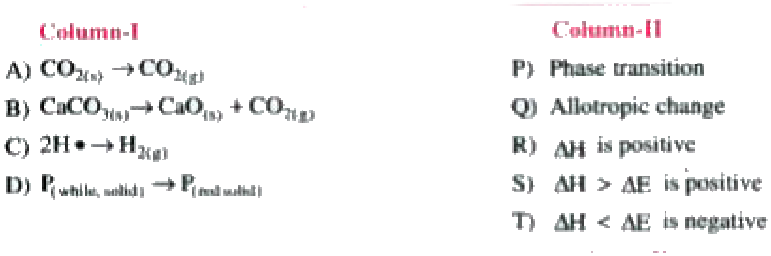
PRACTICE SHEET (EXERCISE- II) (LEVEL- II (ADVANCED) MATRIX MATCHING TYPE QUESTIONS)

1. Match the following columns



Column-I	Column-II
A) $CO_{2(s)} \rightarrow CO_{2(g)}$	P) Phase transition
B) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$	Q) Allotropic change
C) $2H\bullet \rightarrow H_{2(g)}$	R) ΔH is positive
D) $P_{(\text{while, solid})} \rightarrow P_{(\text{red solid})}$	S) $\Delta H > \Delta E$ is positive
	T) $\Delta H < \Delta E$ is negative

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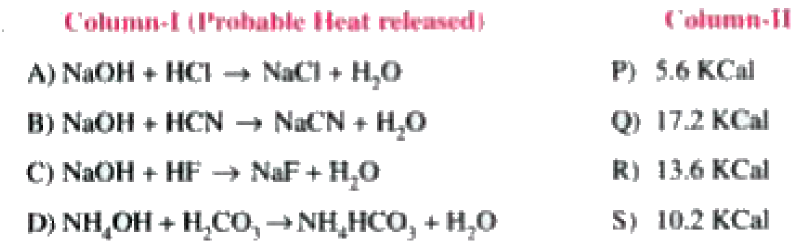
2. Match the following columns



Column-I (Probable Heat released)	Column-II
A) $NaOH + HCl \rightarrow NaCl + H_2O$	P) 5.6 KCal
B) $NaOH + HCN \rightarrow NaCN + H_2O$	Q) 17.2 KCal
C) $NaOH + HF \rightarrow NaF + H_2O$	R) 13.6 KCal
D) $NH_4OH + H_2CO_3 \rightarrow NH_4HCO_3 + H_2O$	S) 10.2 KCal

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PRACTICE SHEET (EXERCISE- II) (LEVEL- II (ADVANCED) INTEGER TYPE QUESTIONS)

1. For the reaction, $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$. Heat of reaction at constant volume exceeds the heat of reaction at constant pressure by the value of xRT. The value of x is_____

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2. Calculate the standard internal change in multiples of $-10^2 KJ$ for the reaction $OF_{2(g)} + H_2O_{(g)} \rightarrow O_{2(g)} + 2HF_{(g)}$ at 298K. The standard enthalpies of formation of $OF_{2(g)}, H_2O_{(g)}, HF_{(g)}$ are $+20$, -250 and $-270 KJ\text{mole}^{-1}$

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3. The enthalpy change when 50 mL of 0.01 M $Ca(OH)_2$ reacts with 25 mL of 0.01 M HCl is $5(x + 2)$ can Given that ΔH^0 neutralisation of a strong acid and a strong base in 140 kCal mol^{-1}. What is x?

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4. Heat of formation of 2 moles of $NH_3(g)$ is $- 90kJ$l bond energies of H-H and N-H bonds are 435 kJ and $390kJmol^{-1}$ respectively. The value of the bond energy of $N \equiv N$ is $\left(1000 - \left(x^2 + x + 25\right)\right)$ kJ/mol What is x ?

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5. Heats of atmoisation of ozone and oxygen are 25 units and 30 units respectively. What is the heat of ozonisation of one mole of oxygen is the same units?

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6. Compute the heat of formation of liquid methyl alcohol in kilojoules per mole, using the following data. Heat of vapourisation of liquid methyl alcohol= 38 kJ/mol. Heat of formation of gaseous atoms from the elements in their standard states, H= 218kJ/mol, C= 715 kJ/mol, O= 249 kJ/mol. Average bond energies, C-H = 415 kJ/mol, C-O = 365 kJ/mol, O-H= 463 kJ/mol

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PRACTICE SHEET (EXERCISE- III) (LEVEL- I (MAIN) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. The least random state of H_2O system is

A. Ice

B. Liquid water

C. Steam

D. Randominess is same in all

Answer: A

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2. For which of the process, ΔS is negative?

A. $H_{2(g)} \rightarrow 2H_{(g)}$

B. $N_{2(g)}(1atm) \rightarrow N_{2(g)}(8atm)$

C. $2SO_{3(g)} \rightarrow 2SO_{2(g)} + O_{2(g)}$

D. $C_{(\text{diamond})} \rightarrow C_{(\text{graphite})}$

Answer: B

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3. When one mole of an ideal gas is compressed to half of its initial volume and simultaneously heated to twice its initial temperature, the change in entropy of gas (ΔS) is

A. $C_{p,m}\ln 2$

B. $C_{v,m}\ln 2$

C. R ln 2

D. $\left(C_{v,m} - R\right)\ln 2$

Answer: D

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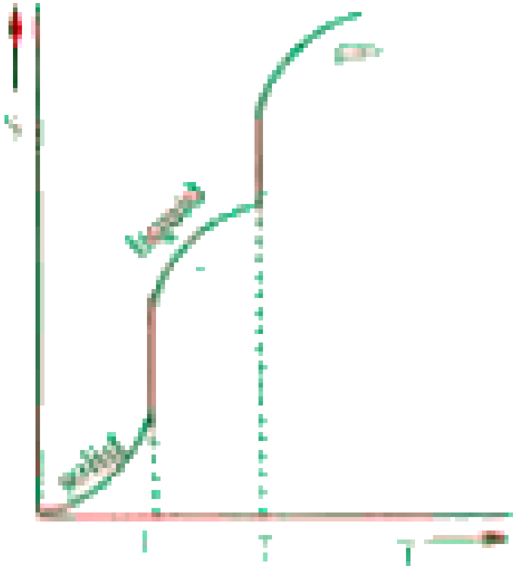
4. Here T_1 and T_2 are



A. M, P, B, P

B. B.P, B.P

C. B.P, M.P

D. M. P, M.P

Answer: A

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5. What is the melting point of benzene if $\Delta H_{\text{fusion}} = 9.95 kJ/mol$ and $\Delta S_{\text{fusion}} = 35.7 J/K\text{-}mol$?

A. $278.7^\circ C$

B. 278.7K

C. 300K

D. 298K

Answer: B

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6. At $0^{\circ} C$ ice and water are in equilibrium and $\Delta H = 6.0 KJ$ then ΔS will be

A. $22 JK^{-1} mol^{-1}$

B. $35 JK^{-1} mol^{-1}$

C. $48 JK^{-1} mol^{-1}$

D. $100 JK^{-1} mol^{-1}$

Answer: A

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7. ΔS_{surr} for $H_2 + 1/2 O_2 \rightarrow H_2O, \Delta H - 280 kJ$ at 400K is

A. 700J/g K

B. 700 kJ/mol/K

C. 700 J/mol/K

D. 0.7 J/mol/K

Answer: C

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8. The incorrect statement according to second law of themodynamics is

A. Heat cannot flow from colder body to a hotter body of its own

B. All spontaneous processes are themody-namically irreversible

C. Heat can be converted into work completely without causing some permanent change in the system (or) surroundings

D. Perpetual motion machine of second kind is not possible

Answer: C

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9. In standard state the non spontaneous reaction among the following is

A. Melting of ice

B. Natural radioactivity

C. Freezing of water

D. Rusting of iron

Answer: C

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10. Some statements are given with regard to entropy. The incorrect statement(s) are

(A) The absolute entropy of substances cannot be determined

(B) In standard state entropy of elements is always positive

(C) The entropy of universe always decreases

(D) In a spontaneous process, for an isolated system the entropy of the system generally increases

A. A, B

B. B,C

C. A,C

D. only C

Answer: C

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11. When a liquid evaporates, which is true about the signs of the enthalpy and entropy changes?

A. $\begin{array}{cc} \Delta H & \Delta S \\ + & - \end{array}$

B. $\begin{array}{cc} \Delta H & \Delta S \\ + & + \end{array}$

C. $\begin{array}{cc} \Delta H & \Delta S \\ - & - \end{array}$

D. $\begin{array}{cc} \Delta H & \Delta S \\ - & + \end{array}$

Answer: B

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12. Although the dissolution of ammonium chloride in water is an endothermic reaction, even then it is spontaneous because

A. ΔH is positive , ΔS is -ve

B. ΔH is + ve, ΔS is zero

C. ΔH is positive, $T\Delta S < \Delta H$

D. ΔH is +ve, ΔS is positive and $\Delta H < T\Delta S$

Answer: D

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13. For a certain reaction, ΔH^0 & ΔS^0 respectively are 400kJ & 200 J/mol/K. The process is non-spontaneous at

A. 2100K

B. 2010K

C. 1990K

D. 2020K

Answer: C

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14. Which of the following conditions regarding a chemical process ensures its spontaneity at all temperatures?

A. $\Delta H > 0, \Delta H < 0$

B. $\Delta H < 0, \Delta S > 0$

C. $\Delta H < 0, \Delta S < 0$

D. $\Delta H > 0, \Delta S < 0$

Answer: B

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15. 

LIST-I (Freezing of water)	LIST-II
A) Water at $-10^{0}C$	I) $\Delta G = 0$
B) Water at $0^{0}C$	II) $\Delta G = +Ve$
C) Water at $+10^{0}C$	III) $\Delta G = -Ve$

The correct match is

The correct match is

A. $\begin{array}{ccc} A & B & C \\ 2 & 1 & 3 \end{array}$

B. $\begin{array}{ccc} A & B & C \\ 3 & 1 & 2 \end{array}$

C. $\begin{array}{ccc} A & B & C \\ 1 & 2 & 3 \end{array}$

D. $\begin{array}{ccc} A & B & C \\ 3 & 2 & 1 \end{array}$

Answer: B

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16. Which of the following expressions is correct?

A. $\Delta G^{\circ} = -nFE^{\circ}$

B. $\Delta G^\circ = +nFE^\circ$

C. $\Delta G^\circ = -2.303RT\ln FE^\circ_{\text{cell}}$

D. $\Delta G^\circ = -nF\log K_C$

Answer: A

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17. Based on the third law of themodynamics, the entropy can be obtained using the equation.

A. $\Delta S = \dfrac{\Delta H}{T}$

B. $\overset{T}{\int} 0T.\,C_P^{-1}dT = S$

C. $\Delta G = T\Delta S$

D. $\int_0^T C_P T^{-1}dT = S$

Answer: D

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PRACTICE SHEET (EXERCISE- III) (LEVEL- II (ADVANCED) (STRAIGHT OBEJCETIVE TYPE QUESTIONS)

1. Which has maximum entropy change of vaporisation?

A. water (l)

B. toluene(l)

C. diethyl ether (l)

D. acetone (l)

Answer: A

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2. Melting & boiling point of NaCl respectively are 1080 K & 1600K. ΔS for stage -I & II in $NaCl_{(s)} \overset{I}{\rightarrow} \Delta H_{\text{fus}} = 30kJ NaCl_{(l)} \overset{II}{\rightarrow} \Delta H_{\text{vap}} = 160kJ$ are

A. $\Delta S(I)(KJ/mol/K)$ $\Delta S(II)(KJ/mol/K)$
$1/36$ $1/10$

B. $\Delta S(I)(KJ/mol/K)$ $\Delta S(II)(KJ/mol/K)$
36 100

C. $\Delta S(I)(KJ/mol/K)$ $\Delta S(II)(KJ/mol/K)$
$1/36$ 10

D. $\Delta S(I)(KJ/mol/K)$ $\Delta S(II)(KJ/mol/K)$
36 $1/10$

Answer: A

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3. Two mole of an ideal gas is expanded irreversibly and isothermally at $37\,^{\circ}C$ until its volume is doubled and 3.41 kJ heat is absorbed from surroundings. ΔS_{total} (system + surroundings) is

A. -0.52 J/K

B. 0.52 J/K

C. 22.52 J/K

D. 0

Answer: B

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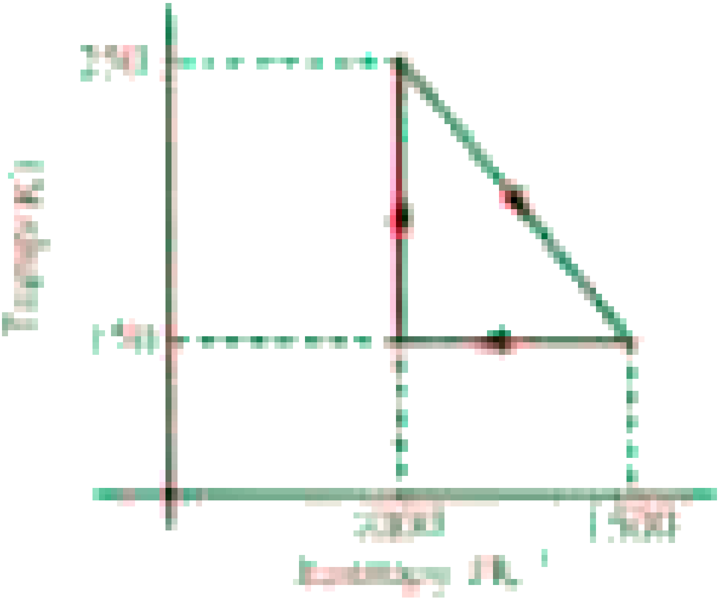
4. The efficiency of the reversible cycle drawn in the fig. will be



A. 0.333

B. 0.56

C. 0.66

D. 0.25

Answer: D

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5. In the conversion of lime stone to lime, $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$, the values of $\Delta H°$ and $\Delta S°$ are + 179.1 kJ mol^{-1} and 160.2 $JK^{-1}mol^{-1}$ respectively at 298K and 1 bar. Assuming, $\Delta H°$ and $\Delta S°$ do not change with temperature, temperature above which conversion of lime stone to lime will be spontaneous is

A. 1118K

B. 1008K

C. 1200K

D. 845K

Answer: A

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6. In an irreversible process taking place at constant T and P and in which only pressure- volume work is being done, the change on Gibb's free energy (dG) and changing in entropy (dS), stisfy the criteria

A. $(dS)_{V,s} < 0, (dG)_{T,P} < 0$

B. $(dS)_{V,E} > 0(dG)_{T,P} < 0$

C. $(dS)_{V,E} = 0, (dG)_{T,P} = 0$

D. $(dS)_{V,E} = 0, (dG)_{T,P} > 0$

Answer: B

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7. The molar entropies of $HI_{(g)}, H_{(g)}$ and $I_{(g)}$ at 298K are 206.5, 114.6, and $180.7Jmol^{-1}K^{-1}$ respectively. Using the ΔG° given below, calculate the bond energy of HI.

$HI_{(g)} \rightarrow H_{(g)} + I_{(g)}, \Delta G^{\circ} = 271.8kJ$ (Give your answer after divide with 49.7)

A. 282.4

B. 298.3

C. 290.1

D. 315.4

Answer: B

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8. For the hypothetical reaction $A_{2(g)} + B_{2(g)} \Leftrightarrow 2AB_{(g)} \Delta_r G^\circ$ and $\Delta_r S^\circ$ are 20 kJ/mol and $-20JK^{-1}mol^{-1}$ respectively at 200K. If $\Delta_r C_P$ is $20JK^{-1}mol^{-1}$ then $\Delta_r H^\circ$ at 400K is

A. 20kJ/mol

B. 7.98kJ/mol

C. 28kJ/mol

D. none of these

Answer: A

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9. For a perfectly crystalline solid $C_{p.m} = aT^3$, where a is constant. If $C_{p.m}$ is 0.42 J/K - mol at 10K, molar entropy at 10K is

A. 0.42J/K -mol

B. 0.14 J/K -mol

C. 4.2 J/K-mol

D. zero

Answer: B

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PRACTICE SHEET (EXERCISE- III) (LEVEL- II (ADVANCED) (MORE THAN ONE CORRECT ANSWER TYPE QUESTIONS)

1. Which statements are correct for a process involving an ideal gas?

A. $(\Delta S)_{\text{Isothermal, sys}} = 2.303 nR \log \frac{V_f}{V_i}$

B. $(\Delta S)_{\text{adiabatic, rev}} = 0$

C. $(\Delta S)_{\text{Total, irr}} > 0$

D. $(\Delta S)_{\text{Total, adiabatic, rev}} = 0$

Answer: A::B::C::D

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2. Which of the following is correct?

A. Reversible adiabatic process is isoentropic

B. ΔS_{sys}, for irreversible adiabatic compression is greater than zero

C. ΔS_{sys} for free expansion is zero

D. ΔS_{sys}, for irreversible isothermal compression is greater than zero

Answer: A::B

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3. Necessary conditions for spontanity of a reaction _______

A. $(G)_{\text{products}} < (G)_{\text{reactants}}$

B. $(S)_{\text{products}} < (S)_{\text{reactants}}$

C. $\left[(\Delta S)_{\text{reaction}} + (\Delta S)_{\text{surr}}\right] > 0$

D. $\left[-\dfrac{(\Delta H)_{\text{sys}}}{T} + (\Delta S)_{\text{sys}}\right] > 0$

Answer: A::C::D

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4. Combustion of sucrose is used by aerobic organisms for providing energy for the life substaining process. If all the capturing from the reaction is done through electrical process (non P-V work) then calculate maximum available energy which can be captured by combustion of 34.2 gm of sucrose Given :

$\Delta H_{\text{sucrose}} = -6000 kJmol^{-1}, \Delta S_{\text{combustion}} = 180 J/Kmol$ and body temperature is 300 K.

A. 600kJ

B. 594.6 kCal

C. 144.83 k Cal

D. 605.4 kJ

Answer: C::D

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5. Driving force of a reaction is the

A. resultant of enthalpy and entropy change

B. resultant of enthalpy and internal energy change

C. resultant of entropy and internal energy change

D. term concerned with change in free energy

Answer: A::D

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6. Signa of ΔG for the melting of ice is negative at

A. 265K

B. 270K

C. 277K

D. 274K

Answer: C::D

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7. In an electrochemical cell $\Delta G = \Delta H$

A. $T \rightarrow 0$

B. $T \rightarrow \infty$

C. $\left(\frac{dE_{\text{cell}}}{dT}\right)_P = 0$

D. $dE_{\text{cell}} = 0$

Answer: A::C::D

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8. If $\Delta G = \Delta H - T\Delta S$ and $\Delta G = \Delta H + T\left[\frac{d(\Delta G)}{dT}\right]_P$ then variation of emf of a cell E, with temperature T is given by:

A. $\frac{\Delta H}{nF}$

B. $\frac{\Delta H - \Delta G}{nFT}$

C. $\frac{\Delta S}{nF}$

D. - $\frac{\Delta S}{nF}$

Answer: B::C

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PRACTICE SHEET (EXERCISE- III) (LEVEL- II (ADVANCED) (LINKED COMPREHENSION TYPE QUESTIONS)

1. The thermodynamic property that measures the extent of molecular disorder is called entropy. The direction of a spontaneous process for which the energy is constant is always the one that increases the molecular disorder. Entropy change of phase transformation can be calculated using Trouton's formula $\left(\Delta S = \frac{\Delta H}{T}\right)$. In the reversible adiabatic process, however, ΔS will be zero. The rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system. $\Delta S = 2.303 C \log\left(T_1 / T_2\right)$, $\left(C = C_P \text{ or } C_V\right)$

If water in an insulated vessel at $-10^\circ C$, suddenly freezes, the entropy change of the system will be

A. zero

B. always positive

C. always negative

D. sometimes positive and sometimes negative

Answer: A

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2. The thermodynamic property that measures the extent of molecular disorder is called entropy. The direction of a spontaneous process for which the energy is constant is always the one that increases the molecular disorder. Entropy change of phase transformation can be calculated using Trouton's formula $\left(\Delta S = \frac{\Delta H}{T}\right)$. In the reversible adiabatic process, however, ΔS will be zero. The rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system. $\Delta S = 2.303C\log\left(T_1/T_2\right), \left(C = C_P \text{ or } C_V\right)$

If water in an insulated vessel at $-10^{\circ} C$, suddenly freezes, the entropy change of the system will be

A. $+ve$

B. $-ve$

C. zero

D. equal to that of surroundings

Answer: A

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3. The thermodynamic property that measures the extent of molecular disorder is called entropy. The direction of a spontaneous process for which the energy is constant is always the one that increases the molecular disorder. Entropy change of phase transformation can be calculated using Trouton's formula $\left(\Delta S=\frac{\Delta H}{T}\right)$. In the reversible adiabatic process, however, ΔS will be zero. The rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system. $\Delta S = 2.303C\log\left(T_1/T_2\right), \left(C = C_P \text{ or } C_V\right)$

The melting point of a solid is 300K and its latent heat of fusion is 600 cal mol^{-1}. The entropy change for the fusion of 1 mole of the soli (in cal K^{-1}) at the same temperature would be:

A. 200

B. 2

C. 0.2

D. 20

Answer: B

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4. Consider the following reaction :

$$CO_{(g)} + 2H_{2(g)} \Leftrightarrow CH_3OH_{(g)}$$

Given : $\Delta_r H^\circ\left(CH_3OOH, g\right) = -201k\frac{J}{m}ol, \Delta_r H^\circ(CO, g) = -114k\frac{J}{m}ol$

$S^\circ\left(CH_3OOH, g\right) = 240\frac{J}{K} - mol, S^\circ\left(H_2, g\right) = 29JK^{-1}mol^{-1}$

$S^\circ(CO, g) = 198\frac{J}{m}ol - K, C^\circ\_(p, m)\left(H_2\right) = 28.8\frac{J}{m}ol - K$

$C^\circ\_(p, m)(CO) = 29.4\frac{J}{m}ol - K, C^\circ\_(p, m)\left(CH_3OH\right) = 44\frac{J}{m}ol - K$

and $\ln\left(\frac{320}{300}\right) = 0.06$, all data at 300 K

$\Delta_r S^\circ$ at 300 K for the reaction is :

A. 152.6 J/K - mol

B. 181.6 J/K - mol

C. - 16 J/K - mol

D. none of these

Answer: C::D

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5. Consider the following reaction :

$CO_{(g)} + 2H_{2(g)} \Leftrightarrow CH_3OH_{(g)}$

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and $\ln\left(\frac{320}{300}\right) = 0.06$, all data at 300 K

$\Delta_r H^\circ$ at 300 K for the reaction is :

A. -87 kJ/mol

B. 87 kJ/mol

C. -315 kJ/mol

D. -288 kJ/mol

Answer: A

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6. Consider the following reaction :

$CO_{(g)} + 2H_{2(g)} \Leftrightarrow CH_3OH_{(g)}$

Given : $\Delta_r H^\circ\left(CH_3OH, g\right) = -201k\frac{J}{m}ol, \Delta_r H^\circ(CO, g) = -114k\frac{J}{m}ol$

$$S^{\circ}\left(CH_3OOH, g\right) = 240\frac{J}{K} - mol, S^{\circ}\left(H_2, g\right) = 29JK^{-1}mol^{-1}$$

$$S^{\circ}(CO, g) = 198\frac{J}{m}ol - K, C^{\circ}\_(p, m)\left(H_2\right) = 28.8\frac{J}{m}ol - K$$

$$C^{\circ}\_(p, m)(CO) = 29.4\frac{J}{m}ol - K, C^{\circ}\_(p, m)\left(CH_3OH\right) = 44\frac{J}{m}ol - K$$

and $\ln\left(\frac{320}{300}\right) = 0.06$, all data at 300 K

$\Delta_r S^{\circ}$ at 320 K is :

A. 155.18 J/mol-K

B. 150.02 J/mol-K

C. 172 J/mol-K

D. none of these

Answer: D

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PRACTICE SHEET (EXERCISE- III) (LEVEL- II (ADVANCED) (MATRIX MATCHING TYPE QUESTIONS)

1. Match the following columns

Column-I	Column-II
A) $(\Delta G_{system})_{T,P}$	P) $nR\ln\left(\frac{V_2}{V_1}\right)$
B) Work done in reversible isothermal ideal gas expansion	Q) $nRT\ln\left(\frac{P_2}{P_1}\right)$
C) ΔG for reversible isothermal expansion of an ideal gas	R) $-nFE$
D) ΔS_{gas} for isothermal expansion of an ideal gas	S) $nR\ln\left(\frac{P_1}{P_2}\right)$

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2. Match the following columns

Column-I (One mole ideal gas)	Column-II
A) $\left[\frac{\partial(\Delta H)}{\partial T}\right]$	P) ΔV
B) $\left[\frac{\partial(\Delta E)}{\partial T}\right]$	Q) $-\Delta S$
C) $\left[\frac{\partial(\Delta G)}{\partial T}\right]_P$	R) ΔC_V
D) $\left[\frac{\partial(\Delta G)}{\partial P}\right]_T$	S) ΔC_P

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PRACTICE SHEET (EXERCISE- III) (LEVEL- II (ADVANCED) (INTEGER TYPE QUESTIONS)

1. A quantity of 4.0 moles of an ideal gas at $20^\circ C$ expands isothermally against a constant pressure of 2.0 atm from 1.0 L to 10.0L. What is the entropy change of the system (in cals)?

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2. At $27^\circ C$ latent heat of fusion of a compound is $2.7 \times 10^3 Jmol^{-1}$. Calculate the entropy change during fusion

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3. For a liquid, enthalpy of fusion is 1.435 kCal mol^{-1} and molar entropy change is 5.26 cal $mol^{-1}K^{-1}$. The freezing point of liquid in celcius will be

____

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4. Calculate equilibrium constant (in multiples of 10^{-80}) when sodium reduces Aluminium oxide to aluminium at 298 K. $\Delta G^{\circ}\_(f)$ of $Na_2O_{3(s)}$ at $298K = -377KJ\text{mole}^{-1}$ and $\Delta G^{\circ}\_(f)$ of Al_2O_3 at $298K = -1582KJ\text{mole}^{-1}$)

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5. For a liquid the vapour pressure is given by $\log_{10}P = \frac{-400}{T} + 10$ Vapour pressure of the liquid is 10^x mm Hg at 400K. The value of x will be ______

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ADDITIONAL PRACTICE EXERCISE (LEVEL - I (MAIN))

1. Which among the following is not an exact differential?

A. Q (dQ= heat absorbed)

B. U(dU = change in internal energy)

C. S(dS = entropy change)

D. G(dG= Gibbs free energy change)

Answer: A

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2. A system consisting of one mole of an ideal diatomic gas absorbs 200J of heat and does 50J of work on surroundings. What is the change in temperature if vibrational modes of motion are inactive?

A. $\dfrac{150Jmol^{-1}}{8.314 \times \frac{5}{2}}$

B. $\dfrac{150Jmol^{-1}}{8.314 \times \frac{3}{2}}$

C. $\dfrac{150Jmol^{-1}}{8.314 \times \frac{7}{2}}$

D. $\dfrac{150Jmol^{-1}}{8.314 \times \frac{4}{3}}$

Answer: A

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3. A mono atomic ideal gas undergoes a process in which the ratio of P to V at any instant is constant and equal to 1. What is molar heat capacity of the gas.

A. $\frac{4R}{2}$

B. $\frac{3R}{2}$

C. $\frac{5R}{2}$

D. 0

Answer: A

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4. 1 mole each of CaC_2, Mg_2C_3 reacts with excess water in separate open flasks work done by the gas during the dissolution shows the order:

A. $CaC_2 = Mg_2C_3 < Al_4C_3$

B. $CaC_2 = Mg_2C_3 = Al_4C_3$

C. $Mg_2C_3 < CaC_{-2} < Al_{40C_3}$

D. $Mg_2C_3 < Al_4C_3 < CaC_2$

Answer: A

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5. The temperature of 5 moles of a gas is decreased by 2K at constant pressure of 1 atm. Indicate the correct statement

A. Work done by gas is = 5R

B. Work done on the gas is = 10R

C. Work done by the gas = 6R

D. Work done = 0

Answer: B

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6. When an ideal gas at a pressure P, temperature T and volume V is isothermally compressed to $\left(\frac{V}{n}\right)$, its pressure becomes P_{iso} and if the same process is carried out adiabatically and reversibly, its pressure becomesP_{adia}. Which of the following is correct for $\frac{P_{\text{iso}}}{P_{\text{adia}}}$?

A. 1

B. n

C. n^{γ}

D. $n^{1-\gamma}$

Answer: D

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7. Which of the following statement is incorrect?

A. The entropy of the universe increases and tends towards the maximum value in irreversible process

B. All the natural spontaneous processes are irreversible in nature

C. For the isothermal expansion of an ideal gas, ΔH and ΔE are not equal

D. The heat of formation of an element in the standard state is zero

Answer: C

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8. A gas absorbs 100 calories of heat energy and is compressed from 10L to 5L by applying an external pressure of 2 atm. Change in internal energy in calories will be nearly.

A. 312

B. 342

C. 426

D. 562

Answer: B

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9. Given below are some standard heats of reaction (at constant pressure)

(A) Heat of formation of water = -68.3 kcal

(B) Heat of combustion of acetylene = - 310.6 kcal

(C) Heat of combustion of ethylene = - 337.2 kcal

Calculating the heat of reaction for the hydrogenation of acetylene at constant pressure and at constant volume (at $25^\circ C$)

A. at constant pressure -41.104 kcal

B. at constant volume $= -41.7$ kcal

C. at constant pressure = -41.7 kcal

D. at constant volume $= -42.104$ kcal

Answer: C

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10. The enthalpy of neutralization of weak monoprotic acid, HA in 1M solution with a strong base is -55.95 KJ/mol if the unionised acid requires 1.4 KJ/mol heat for its complete ionization and enthalpy of neutralisation of the strong monobasic acid with a strong monoacidic base is $= -57.3$ KJ/mol. What will be $\%$ ionization of weak acid in molar solution is

A. $1.2\ \%$

B. 0.0357

C. 0.0607

D. 0.1201

Answer: B

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11. The heat of combustion of hydrocarbon C_xH_y is "a" calories and heat of formation of CO_2 and H_2O are "b" and 'c' calories respectively then the heat of formation of hydrocarbon C_8H is (in calories)

A. $xa + yc - b$

B. $xb + yc - a$

C. $b + xc - xa$

D. $xb + \frac{y}{2}c - a$

Answer: D

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12. The standard enthalpy of formation of hypothetical MgCl is $-125kJmol^{-1}$ and for $MgCl_2$ is -642 kJ mol^{-1}. What is the enthalpy of the disproportionation of MgCl ?

A. $-492kJmol^{-1}$

B. $-392kJmol^{-1}$

C. $-767kJmol^{-1}$

D. $-517kJmol^{-1}$

Answer: B

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13. Calculate the resonance energy of N_2O from the following data ΔH_f of $N_2O = 82$ kJ mol^{-1}. Bond energies of $N \equiv N, N = N, O = O$ and $N = O$ bond are 946, 418 and 607 kJ mol^{-1} respectively

A. $-88kJmol^{-1}$

B. $-170kJmol^{-1}$

C. $-82kJmol^{-1}$

D. $-258kJmol^{-1}$

Answer: A

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ADDITIONAL PRACTICE EXERCISE (LEVEL - II LECTURE SHEET (ADVANCED) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. When 3.0 mole of an ideal diatomic gas is heated and compressed simultaneously from 300K, 1.0 atm to 400K and 5.0atm, the change in entropy is (Use $C_P = \frac{7}{2}R$ for the gas)

A. $-20JK^{-}$

B. $-5JK^{-}$

C. $-15JK^{-}$

D. $-2.8JK^{-}$

Answer: C

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2. State$P_1, V_1, T_1A \overset{\text{Rev}}{\rightarrow}$ State BP_2, V_2, T_2: If $P_1 = P_2$ then

A. $\Delta S\text{universe} = 0$

B. $\Delta S\text{universe} = 1$

C. $\Delta S\text{universe} > 0$

D. $\Delta S\text{universe} < 0$

Answer: A

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3. During winters, moisture condenses in the form of dew and can be seen on plant leaves and grass. The entropy of the system in such cases decreases as liquids possess lesser disorder as compared to gases. With reference to the second law, which statement in correct, for the above process?

A. The randomness of the universe decreases

B. The randomness of the surroundings decreases

C. Increase in randomness of surroundings equals the decrease in randomness of system

D. The increase in randomness of the surroundings is greater as compared to the decrease in randomness of the system.

Answer: D

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4. Assuming ΔH^0 and ΔS^0 do not change with temperature the boiling point of liquid "A" (the thermodynamics data given below) is

Thermodynamics	A (liq)	A (gas)
$\Delta H^0 (kJ/mol)$	-130	-100
$S^0 (JK^{-1} mol^{-1})$	100	200

A. 300K

B. 13K

C. 150K

D. 50K

Answer: A

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5. For the reaction $X_2O_{4(l)} \rightarrow 2XO_{2(g)}, \Delta U = 2.1\text{kcal}, \Delta S = 20\text{cal } K^{-1}$ at 300K, Hence ΔG is

A. 2.7 kcal

B. -2.7 kcal

C. 9.3 kcal

D. -9.3 kcal

Answer: B

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6. The correct signs of ΔS for the following four processes respectively are

(i) Devitrification of glass (ii) Desalination of sea water (iii) N_2 (g, 10 atm) $\rightarrow$ N_2(g, 2 atm) (iv) C (s, graphite) $\rightarrow$ C (s, daimond)

A. -, -, +, -

B. +, -, +, -

C. +, -, -, -

D. -, -, -, -

Answer: A

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7. Work (W) is the path function. Which of the following order is incorrect?

A. $W_{\text{adiabatic}} > W_{\text{Isothermal}}$

B. $W_{\text{reversible}} > W_{\text{ireversible}}$

C. $W_{\text{isobaric}} > W_{\text{Isochoric}}$

D. for a cyclic process W = area of cycle

Answer: A

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8. Standar entropies of x_2, y_2 and xy_3 are 60,40 and $50JK^{-1}mol^{-1}$ respectively for the reaction to be at equilibrium, the temperature should be

$$\frac{1}{2}x_2 + \frac{3}{2}y_2 \Leftrightarrow xy_3 \Delta H = -30kJ$$

A. 750K

B. 1000K

C. 1250K

D. 500K

Answer: A

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ADDITIONAL PRACTICE EXERCISE (LEVEL - II LECTURE SHEET (ADVANCED) MORE THAN ONE CORRECT ANSWER TYPE QUESTIONS)

1. Temperature of an ideal gas increases in:

A. Adiabatic expansion

B. adiabatic compression

C. Isothermal expansion

D. isobaric expansion

Answer: B::D

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2. As a rubber band is stretched, it gets warmer, when released, it gets cooler. The correct sign of thermodynamic parameters for stretching of rubber band is

A. $\Delta H = -ve$

B. $\Delta H = +ve$

C. $\Delta S = -ve$

D. $\Delta S = +ve$

Answer: A::C

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3. A system undergoes two cyclic process 1 and 2. Process 1 is reversible and process 2 is irreversible. The correct statement relating to the two processes is

A. ΔS (for process 1) = 0, while ΔS (for process 2) $\neq 0$

B. $q_{\text{cyclic}} = 0$ for process 1 and $q_{\text{cyclic}} \neq 0$ for process 2

C. More heat can be converted to work in process 1 than in process 2

D. More work can be converted to heat in process 1 than in process 2

Answer: C::D

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4. A certain gas is expanded from (1L, 10atm) to (4L, 5atm) against a constant external pressure of 1 atm. If the initial temperature of gas is 300K and heat capacity for the process is $50 J^{\circ} C^{-1}$ (use 1L atm = 100J), then

A. $|W| = 0.3kJ$

B. $|q| = 15kJ$

C. $\Delta U = 14.7kJ$

D. $\Delta H = 15.7kJ$

Answer: A::B::C::D

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5. The standard enthalpies of formation of CO_2 gas and $HCOOH_{(l)}$ are -393.7 kJ mol^{-1} and $-409.2kJmol^{-1}$ respectively. Which of the following are correct?

A. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -393.7kJmol^{-1}$

B. $CO_{2(g)} + H_{2(g)} \rightarrow HCOOh_{(l)}, \Delta H = -15.5kJmol^{-1}$

C. $H_2O_{(l)} + CO_{(g)} \rightarrow HCOOH_{(l)}, \Delta H = -409.2kJmol^{-1}$

D. $C_{(s)} + H_{2(g)} + O_{2(g)} \rightarrow H_2CO_{2(l)}, \Delta H = -409.2kJmol^{-1}$

Answer: A::B::D

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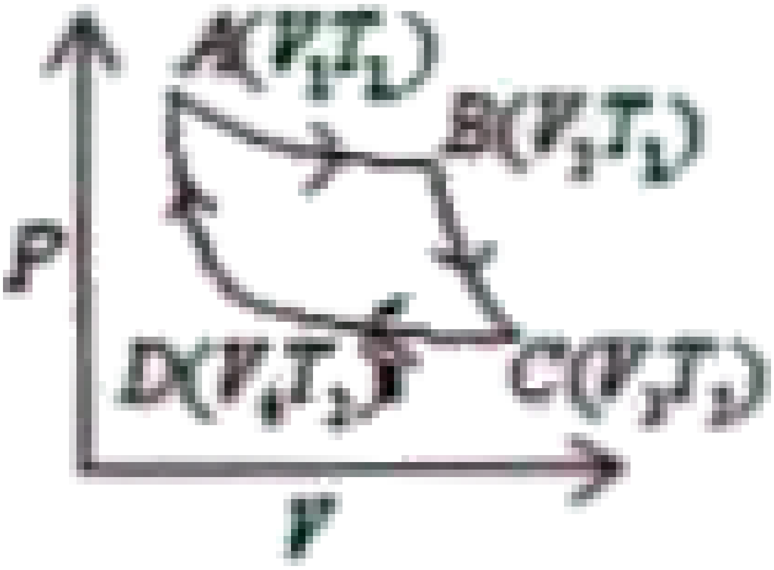
6. For this process (overall change) which is correct



A. q= 0, W= 0

B. $q = +ve, W = -ve$

C. $q = -ve, W_{\text{on the system}} = +ve$

D. $\Delta S_{\text{sys}} = 0, \Delta U_{\text{sys}} = 0, \Delta H_{\text{sys}} = 0$

Answer: B::D

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7. P and Q are two arbitrarily chosen intensive variables then

A. (P + Q) is extensive property

B. $\frac{P}{Q}$ is an intensive variable

C. PQ is an intensive variable

D. $\frac{dP}{dQ}$ = intensive variable

Answer: B::C::D

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ADDITIONAL PRACTICE EXERCISE (LEVEL - II LECTURE SHEET (ADVANCED) LINKED COMPREHENSION TYPE QUESTIONS)

1. A flask of 1L having $NH_3(g)$ at 2.0atm and 200K is connected with another flask of vol 800ml having HCl(g) at 8atm & 200K through tube of negligible volume. The two gases reacts to form $NH_4Cl(s)$ with evolution of 43 KJ/mol heat. If heat capacity of at constant volume is 20J/K/mol and neglecting heat capacity of flask and solid, volume of solid formed and its pressure (R = 0.08).

The final pressure in the flask is

A. 5.375KJ

B. 4.375KJ

C. 6.8KJ

D. 6.375J

Answer: A

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2. A flask of 1L having $NH_3(g)$ at 2.0atm and 200K is connected with another flask of vol 800ml having HCl(g) at 8atm & 200K through tube of negligible volume. The two gases reacts to form $NH_4Cl(s)$ with evolution of 43 KJ/mol heat. If heat capacity of at constant volume is 20J/K/mol and neglecting heat capacity of flask and solid, volume of solid formed and its pressure (R = 0.08).

The final pressure in the flask is

A. 14.39 atm

B. 1.49 atm

C. 16.39 atm

D. 15. 39 atm

Answer: A

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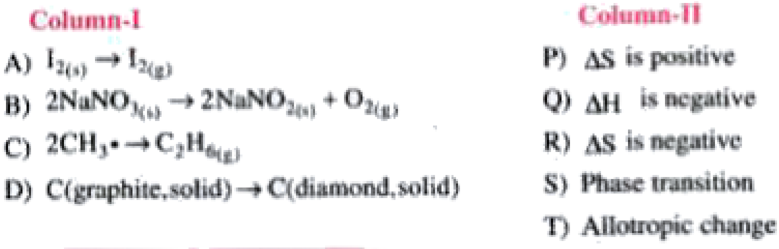
ADDITIONAL PRACTICE EXERCISE (LEVEL - II LECTURE SHEET (ADVANCED) MATRIX MATCHING TYPE QUESTIONS)

1. Match the following columns



Column-I	Column-II
A) $I_{2(s)} \rightarrow I_{2(g)}$	P) ΔS is positive
B) $2NaNO_{3(s)} \rightarrow 2NaNO_{2(s)} + O_{2(g)}$	Q) ΔH is negative
C) $2CH_3\bullet \rightarrow C_2H_{6(g)}$	R) ΔS is negative
D) C(graphite,solid) → C(diamond,solid)	S) Phase transition
	T) Allotropic change

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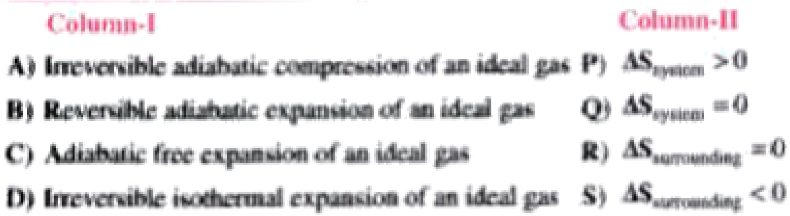
2. Match the following columns



Column-I	Column-II
A) Irreversible adiabatic compression of an ideal gas	P) $\Delta S_{system} > 0$
B) Reversible adiabatic expansion of an ideal gas	Q) $\Delta S_{system} = 0$
C) Adiabatic free expansion of an ideal gas	R) $\Delta S_{surrounding} = 0$
D) Irreversible isothermal expansion of an ideal gas	S) $\Delta S_{surrounding} < 0$

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ADDITIONAL PRACTICE EXERCISE (LEVEL - II LECTURE SHEET (ADVANCED) INTEGER TYPE QUESTIONS)

1. How many of the following processes have +ve sign for entropy change?

(i) $Cl_{2(g)} \Leftrightarrow 2Cl_{(g)}$

(ii) $S_8(\text{rhombic}) \Leftrightarrow 4S_{2(g)}$

(iii) $3O_{2(g)} \Leftrightarrow 2O_{3(g)}$

(iv) 60C (graphite) $\Leftrightarrow C_{60(s)}$

(v) $Ag^{+}_{(aq)} + Br^{-}_{(aq)} \Leftrightarrow AgBr_{(s)} + H_2O$

(vi) $H_2O_{(l)} \Leftrightarrow H_2O_{(s)}$

(vii) $2NH_{3(g)} \Leftrightarrow N_{2(g)} + 3H_{2(g)}$

(viii) $CuSO_{4(g)} + 5H_2O_{(l)} \Leftrightarrow CuSO_4.5H_2O_{(s)}$

(ix) $Ba(OH)_2.10H_2O_{(s)} + 2NH_{40Cl_{(s)}} \Leftrightarrow BaCl_{2(s)} + 2NH_{3(g)} + 12H_2O_{(l)}$

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2. When 1 mole of an ideal monatomic gas is compressed adiabatically the intenal energy change involved is 24 cals. The temperature rise is

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3. The enthalpies of neutralization of a weak acid HA and a weak acid HB by NaOH are -6900 cal/equivalent at -2900 cal/equivalent, respectively. When one equivalent of NaOH is added to a solution containing one equivalent of HA and one equivalent of HB, the enthalpy change was -3900 cal. The ratio in which the base distributed between HB and HA is x/y then x + y is

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4. For isothermal expansion of an ideal gas into vacuum, among the following how many are zero, Pext, g, $\Delta T, \Delta U, \Delta H, \Delta S, \Delta G, \Delta S_{\text{surr}}, \Delta S_{\text{total}}$

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ADDITIONAL PRACTICE EXERCISE (PRACTICS SHEET (ADVANCED) STRAIGHT OBJECTIVE TYPE QUESTIONS)

1. Pick out the correct statement from among the four:

A. When a liquid boils, work is done on the system

B. In case of Boiling of a liquid $\Delta H = \Delta U$

C. When a liquid boils at its boiling temperature, $Q_P = \Delta H$

D. For the process of boiling of a liquid Q = 0

Answer: C

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2. The value of a cylinder containing initially 10L of an ideal gas at 25 atm and $25^\circ C$ is opened to the atmosphere, where the pressure is 760 torr and the temperature is $25^\circ C$. Assuming that the process is isothermal the work in L-atm in the process is:

A. 240 L atm

B. -240 L atm

C. +250 L atm

D. -250 L atm

Answer: B

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3. An ideal gas is allowed to expand both reversibly and irreversibly in an isolated system. If T_1 is initial temperature and T_f is the final temperature, which of the following statement is correct

A. $\left(T_f\right)_{\text{irr}} > \left(T_f\right)_{\text{rev}}$

B. $T_f > T_1$ for reversible process but $T_f = T_1$ for irreversible process

C. $\left(T_f\right)_{\text{rev}} = \left(T_f\right)_{\text{irr}}$

D. $\left(T_f\right) = T_1$ for reversible and irreversible process

Answer: A

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4. A vessel contains 100 litres of a liquid x. Heat is suppllied to the liquid in such a fashion that, Heat given = change in enthalpy. The volume of the liquid increases by 2 lites. If the external pressure is one atm and 202.6 Joules of heat were supplied then,

A. $\Delta U = 0, \Delta H = 0$

B. $\Delta U = +202.6J, \Delta H = +202.6J$

C. $\Delta U = -202.6J, \Delta H = -202.6J$

D. $\Delta U = 0, \Delta H = +202.6J$

Answer: D

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5. If $\Delta G = -177Kcal$ for (1) $2Fe(s) + \frac{3}{2}O_2(g) \rightarrow Fe_2O_3(s)$ and

$\Delta G = -19Kcal$ for (2) $4Fe_2O_3(s) + Fe(s) \rightarrow 3Fe_3O_4(s)$

What is the Gibbs free energy of formation of Fe_3O_4 ?

A. $+229.6\frac{\text{kcal}}{\text{mol}}$

B. $-242.3\frac{\text{kcal}}{\text{mol}}$

C. $-727\frac{\text{kcal}}{\text{mol}}$

D. $-229.6\frac{\text{kcal}}{\text{mol}}$

Answer: B

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6. $C_2H_{6(g)} + 3.5O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$

$\Delta S_{\text{vap}}\left(H_2O, l\right) = x_1 \text{ cal}K^{-1}$ (boiling point is T_1)

$\Delta H_f\left(H_2O, l\right) = x_2, \Delta H_f\left(CO_2\right) = x_3, \Delta H_f\left(C_2H_6\right) = x_4$ Hence ΔH for the reaction is

A. $2x_3 + 3x_2 - x_4$

B. $2x_3 + 3x_2 - x_4 + 3x_1T_1$

C. $2x_3 + 3x_2 - x_4 - 3x_1T_1$

D. $x_1T_1 + X_2 + X_3 - x_4$

Answer: B

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7. Select the correct set of statement/s:

I. Work done by the surrounding in case of infinite stage expansion is more than single stage expansion

II. Irreversible work is always greater than reversible work.

III. On an ideal gas in case of single stage expansion and compression system as well as surrounding are restored back to their original states

IV. If gas is in thermodynamic equilibrium is taken from A to state B, by four successive single stage expansions. Then we can plot 4 points on the P-V indicator diagram.

A. II

B. I, II, III, IV

C. I, IV

D. I, II, IV

Answer: C

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8. Reactions involving gold have been of particular interest to alchemists.

Consider the following reactions,

$Au(OH)_3 + 4HCl^3/_4 \circledR HAuCl_4 + 3H_2O, DH = -28kcal Au(OH)_3 + 4HBr^3/_4 \circledR HAu$

,

$DH = -36.8kcal$

In an experiment there was an absorption of 0.44 kcal when one mole of $HAuBr_4$ was mixed with 4 moles of HCl. Then the fraction of $HAuBr_4$ converted into $HAuCl_4$ (percentage conversion)

A. 0.05

B. 0.06

C. 0.07

D. 0.08

Answer: A

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9. Which of the following statement(s) is/are incorrect:

Statement (a) : Reversible isothermal compression of an ideal gas represents the limiting minimum value of the workdone (lwl) by the surrounding on the system.

Statement (b) : In an irreversible process, the cyclic integral of work is not zero.

Statement (c) : For thermodynamic changes in adiabatic process $T^{\left(\frac{C_{p.m}}{R}\right)}.P$ = constant

Statement (d) : ΔS_{system} is zero for reversible adiabatic expansion of an ideal gas.

A. Statement c

B. Statement a, b, c

C. Statement a, b, d

D. All

Answer: A

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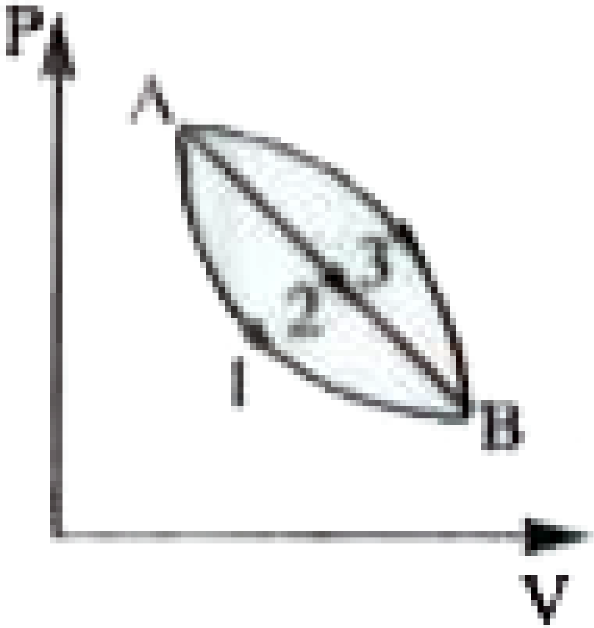
10. A given mass of gas expands from the state A to the state B by three paths 1,2 and 3 as shown in the figure. If w_1, w_2 and w_3 respectively be the work done by the gas along three paths then:



A. $w_1 > w_2 > w_3$

B. $w_1 < w_2 < w_3$

C. $w_1 = w_2 = w_3$

D. $w_2 < w_3 < w_1$

Answer: B

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11. Determine which of the following reactions at constant pressure represent systems that do work on the surrounding environment

I. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ II. $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$

III. $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$

A. I

B. III

C. II and III

D. I and II

Answer: C

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12. A rigid and insulated tank of $3m^3$ volume is divided into two compartments. One second compartment of volume of $2m^3$ contains an ideal gas at 0.8314 Mpa and 400K and while the second compartment of volume $1m^3$ contains the same gas at 8.314 MPa and 500K. If the partition between the two compartments isruptured. the final temperature of the gas is:

A. 420K

B. 450K

C. 480K

D. none of these

Answer: C

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13. 0.5 mole each of two ideal gases $A\left(C_{v.m}=\frac{5}{2}R\right)$ and $B\left(C_{v.m}=3R\right)$ are taken in a container and expanded reversibly and adiabtically, during this process temperature of gaseous mixture decreases from 350K and 250K. Find DH (in cal/mol) for the process

A. $-100R$

B. $-137.5R$

C. $-375R$

D. none of these

Answer: C

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14. The enthalpy of tetramerization on X in gas phase $\left(4X(g)®X_4(g)\right)$ is -100 kJ/mol at 300K. The enthalpy of vaporisation for liquid X and X_4 are respectively 30kJ/mol and 72 kJ/mol respectively. DS for tetramerization of X in liquid phase is -125 J/K mol at 300K. What is the DG at 300K for tetramerization of X in liquid phase?

A. -52 kJ/mol

B. -89.5 kJ/mol

C. -14.5 kJ/mol

D. none of these

Answer: C

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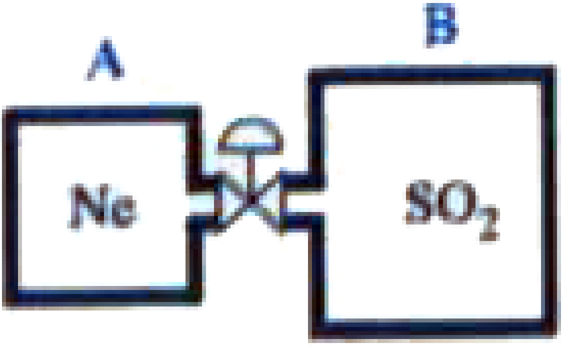
15. Two rigid adiabatic vessels A and B which initially, contain two gases at different temperature are connected by pipe line with value of negligible volume. The vessel 'A' contain 2 moles Ne gas $\left(C_{p.m}=\frac{5}{2}R\right)$ at 300K, vessel 'B' contain 3 moles of SO_2 gas $\left(C_{p.m}=4R\right)$ at 400K. The volume of A & B vessel is 4 and 6 litre respectively. The final total pressure (in atm) when value is opened and 12 Kcal heat supplied through it to vessels.

[Use: R= 2 cal/mol, K and R= 0.08L. atm/mol K as per desire]



A. 3.5 atm

B. 7 atm

C. 35 atm

D. 70 atm

Answer: C

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16. From the following data at $25\,^{\circ}C$

Reaction	$\Delta_rH^{\circ}\ kJ/mol$
$\frac{1}{2}H_2(g)+\frac{1}{2}O_2(g)\rightarrow OH(g)$	42
$H_2(g)+\frac{1}{2}O_2(g)\rightarrow H_2O_g$	-242
$H_2(g)\rightarrow 2H(g)$	436
$O_2(g)\rightarrow 2O(g)$	495

Which of the following statement(s) is/are correct:

Statement (a): Δ_rH° for the reaction $H_2O(g)\rightarrow 2H(g)+O(g)$

Statement (b): Δ_rH° for the reaction $OH(g)\rightarrow H(g)+O(g)$ is

Statement (c) : Enthalpy of formation of H(g) is -218 kJ/mol

Statement (d): Enthalpy of formation of OH(g) is 42 kJ/mol

A. Statement c

B. Statement a, b, c

C. Statement b, c

D. statement a,d

Answer: D

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17. A sample of an ideal gas with initial pressure 'P' and volume 'V' is taken through an isothermal process during which entropy change is found to be DS. The work done by the gas is

A. $\frac{PV\Delta S}{nR}$

B. $nR\Delta S$

C. PV

D. $\frac{P\Delta S}{nRV}$

Answer: A

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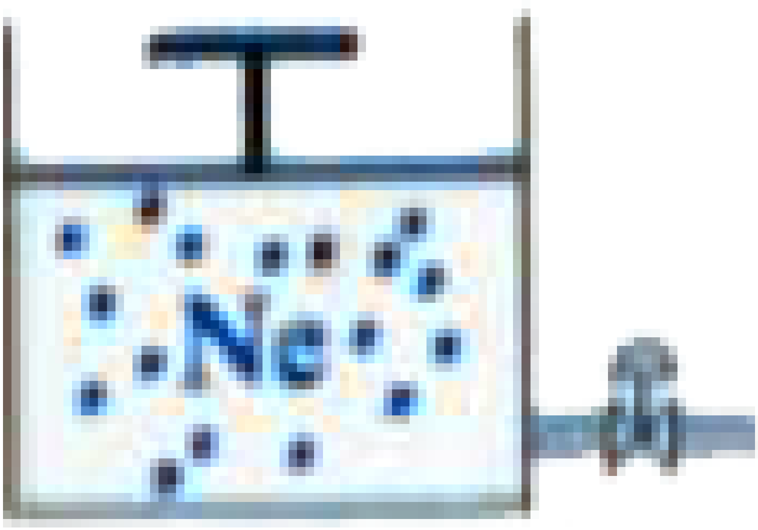
ADDITIONAL PRACTICE EXERCISE (PRACTICS SHEET (ADVANCED) MORE THAN ONE CORRECT ANSWER TYPE QUESTIONS)

1. A piston cylinder device initially contains $0.2m^3$ neon (assume ideal) at 200kPa inside at $T_1\,^{\circ}C$. A valve is now opened and neon is allowed to escape until the volume reduces to half the initial volume. At the same time heat transfer with outside at $T_2\,^{\circ}C$ ensures a constant temperature inside. Select correct statement(s) for given process



A. ΔU must be zero

B. ΔU can not be zero

C. q may be +ve

D. q may be -ve

Answer: B::C

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2. Which of the following statement(s) is/are correct?

A. the system of constant entropy and constant volume will attain the equilibrium in a state of minimum energy

B. the entropy of the universe is on the increase

C. the process would be spontaneous when $\left(\Delta S_{E,V}\right) < 0, (\Delta E)_{S,V} > 0$

D. The process would be spontaneous when $(\Delta S)_{E,V} > 0, (\Delta E)_{S,V} < 0$

Answer: A::B::D

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3. Which of the following statements are correct?

A. For the reaction $CaCO_3$ (calcite) $\rightarrow CaCO_3$ (aragonite) given:

$\Delta_f G^\circ_{298}$ (calcite) = -1128.8 kJ/mol, $\Delta_f G^\circ_{298}$ (aragonite) = -1127.75 kJ/mol,

then calcite form is more stable at standard conditions

B. For the reaction (1) $C_{(\text{diamond})} + 2H_{2(g)} \rightarrow CH_{4(g)}, \Delta H_1$

(2) $C_{(\text{graphite})} + 4H_{(g)} \rightarrow CH_{4(g)}, \Delta H_2$. Then more heat is evolved

in reaction (b)

C. $\Delta_f H^0(I_2, g) = \Delta_{\text{sub}} H^0(I_2, s)$ at $25^\circ C$

D. For the exothermic reaction $2Ag_{(s)} + 1/2O_{2(g)} \rightarrow 2Ag_2O_{(s)}$ at

298K. $\Delta H < \Delta U$

Answer: A::B::C::D

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4. The normal boiling point of a liquid 'A' is 350K. ΔH_{vap} at normal boiling point is 35 kJ/mole. Pick out the correct statement(s). (Assume ΔH_{vap} to be independent of pressure)

A. $\Delta S_{\text{vaporisation}} > 100 J/K$ mole at 350K and 0.5 atm

B. $\Delta S_{\text{vaporisation}} < 100 J/K$ mole at 350K and 0.5 atm

C. $\Delta S_{\text{vaporisation}} < 100 J/K$ mole at 350K and 2 atm

D. $\Delta S_{\text{vaporisation}} = 100 J/K$ mole at 350K and 2 atm

Answer: A::C

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5. Choose the correct statements:

A. Temperature, enthalpy and entropy are state functions

B. For both reversible and irreversible isothermal expansion of an ideal gas, change in internal energy and enthalpy is zero

C. For a reaction in which $\Delta n_g = 0$, entropy change is not always zero

D. The entropy change associated with reversible isothermal expansion of an ideal gas is equal to 2.303 R $\log_{10}\frac{P_1}{P_2}$

Answer: A::B::C::D

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ADDITIONAL PRACTICE EXERCISE (PRACTICS SHEET (ADVANCED) LINKED COMPREHENSION TYPE QUESTIONS)

1. Liquid water freezes at 273K under external pressure of 1 atm. The process is at equilibrium $H_2O(l) \Leftrightarrow H_2O(s)$ at 273 K & 1 atm. However it was required to calculate the thermodynamic parameters of the fusion process occuring at same pressure & different temperature.Using the following data, answer the question that follow. $d_{\text{ice}} = 0.9$ gm/cc, $d_{H_2O(l)}$ = 1 gm//c, $C_P\left[H_2O(s)\right)\right] = 36.4JK^{-1}mol^{-1}$

$C_P\left[H_2O(l)\right] = 75.3JK^{-1}mol^{-1}, \Delta H_{\text{fusion}} = 6008.2Jmol^{-1}$

The value of "ΔH_{fusion}" at 263K & 1 atm will be

A. $+6008.2J\text{mole}^{-1}$

B. $5619.2J\text{mole}^{-1}$

C. $-5619.2 J \text{mole}^{-1}$

D. $6619.2 J \text{mole}^{-1}$

Answer: B

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2. Liquid water freezes at 273K under external pressure of 1 atm. The process is at equilibrium $H_2O(l) \Leftrightarrow H_2O(s)$ at 273 K & 1 atm. However it was required to calculate the thermodynamic parameters of the fusion process occuring at same pressure & different temperature.Using the following data, answer the question that follow. $d_{\text{ice}} = 0.9$ gm/cc, $d_{H_2O(l)}$ = 1 gm//c, $C_P\left[H_2O(s)\right)\right] = 36.4 JK^{-1} mol^{-1}$

$C_P\left[H_2O(l)\right] = 75.3 JK^{-1} mol^{-1}$, $\Delta H_{\text{fusion}} = 6008.2 J mol^{-1}$

"ΔS_{fusion}" at 263 K & 1 atm will be

A. $22.01 JK^{-1} mol^{-1}$

B. $22.84 JK^{-1} mol^{-1}$

C. $21.36JK^{-1}mol^{-1}$

D. $20.557KJ^{-1}mol^{-1}$

Answer: C

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3. 9.0g m ice at $0^{\circ}C$ is mixed with 36gm of water at $50^{\circ}C$ in a thermally insulated container, using the following data, answer the question that follow: $C_{P\left(H_2O\right)} = 4.18Jg^{-1}K^{-1}, \Delta H_{\text{fusion}}$ (ice) = $335Jg^{-1}$

Final tempeature of water is

A. 304.43K

B. 296.97 K

C. 303.93K

D. 287K

Answer: B

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4. 9.0g m ice at $0^{\circ} C$ is mixed with 36gm of water at $50^{\circ} C$ in a thermally insulated container, using the following data, answer the question that follow: $C_{P}\left(H_2O\right) = 4.18 J g^{-1} K^{-1}$, ΔH_{fusion} (ice) = $335 J g^{-1}$

ΔS_{ice} is

A. $11.04 JK^{-1}$

B. $3.16 JK^{-1}$

C. $14.2 JK^{-1}$

D. $7.84 JK^{-1}$

Answer: C

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5. 9.0g m ice at $0^{\circ} C$ is mixed with 36gm of water at $50^{\circ} C$ in a thermally insulated container, using the following data, answer the question that follow: $C_P\left(H_2O\right) = 4.18Jg^{-1}K^{-1}$, ΔH_{fusion} (ice) = $335Jg^{-1}$

ΔS_{water} is

A. $-12.64JK^{-1}$

B. $-0.34JK^{-1}$

C. $-5.42JK^{-1}$

D. $12.64JK^{-1}$

Answer: A

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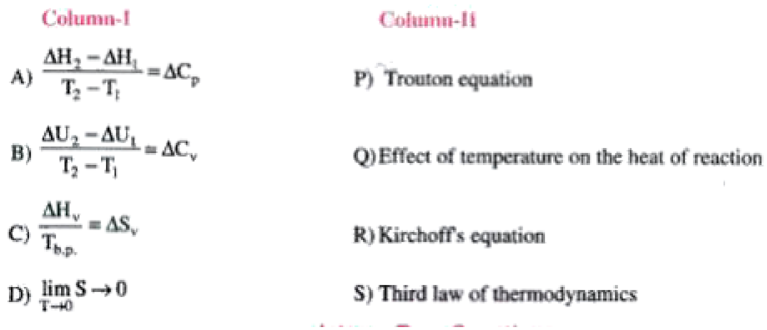
ADDITIONAL PRACTICE EXERCISE (PRACTICS SHEET (ADVANCED) MATRIX MATCHING TYPE QUESTIONS)

1. Match the following columns



Column-I	Column-II
A) $\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_p$	P) Trouton equation
B) $\frac{\Delta U_2 - \Delta U_1}{T_2 - T_1} = \Delta C_v$	Q) Effect of temperature on the heat of reaction
C) $\frac{\Delta H_v}{T_{b.p.}} = \Delta S_v$	R) Kirchoff's equation
D) $\lim_{T \to 0} S \to 0$	S) Third law of thermodynamics

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ADDITIONAL PRACTICE EXERCISE (PRACTICS SHEET (ADVANCED) INTEGER TYPE QUESTIONS)

1. Calculate the pH at which the following conversion (reacton) will be at equilibrium in basic medium $I_{2(s)} \Leftrightarrow I^-_{(aq)} + IO^-_{3(aq)}$. When the equilibrium concentrations at 300 K are $\left[I^-\right]$ = 0.10 and $\left[IO_3^-\right] = 0.10M$ Given that $\Delta G_f^0\left(I^- aq\right) = -50$ kJ/mole, $\Delta G_f^0\left(IO_3^-, aq\right) = -123.5 kJ/\text{mole}, \Delta G_f^0\left(H_2O, l\right) = -233$ kJ/mole,

$\Delta G_f^0\left(OH^-, aq\right)$ = - 150 kJ/mole, Ideal gas constant $= R = \frac{25}{3}$Jmole$^{-1}K^{-1}$,

log e = 2.3,

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2. The enthalpy for the following reaction (at $25\,^\circ C$ are given below):

(i) $½H_{2(g)} + ½O_{2(g)} \rightarrow OH_{(g)}$ = 10.06 Kcal

(ii) $H_{2(g)} \rightarrow 2H_{(g)}$ 104.18 Kcal

(iii) $O_{2(g)} \rightarrow 2O_{(g)}$ 118.32 Kcal

Calculate the O-H bond energy in the hydroxyl radical (give your answer in terms of 10^5 cal)

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3. Consider the following cyclic process carried out in two steps on a gas

Step 1 : 45J of heat is added to the gas, and 10J of expansion work is performed

Step 2: 60J of heat is removed from the gas as the gas is compressed back to the initial state

If the work for the gas compression in step 2 is 19x J, then the value of x is

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PROBLEMS

1. A closed steel Mask contains hot tea. What type of system is this?

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2. Does the temperature remain constant in an adiabatic process ?

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3. 10 grams of steam has higher internal energy than 10 grams of ice. Comment.

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4. A chamber contains $77 g of CO_2$. The chamber was divided into three compartments X, Y and Z as shown below. Suggest the relation between the internal energies of the gas in the three compartments X, Y and Z.

$X\ 11gCO_2 \quad y22gCO_2 \quad Z44gCO_2$

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5. In a process, a system loses 125 J of heat when 400 J of work was done on the system. Calculate the change in internal energy.

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6. A system absorbs 10kJ of heat at constant volume and its temperature rises from 27^0C to 37^0C. The DE of reaction is

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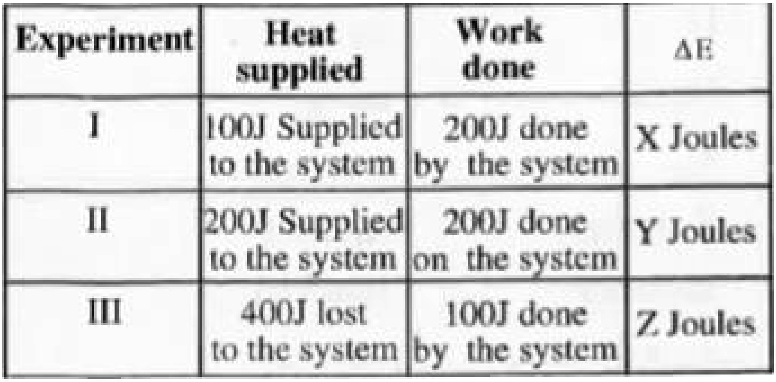
7. From the observations given below, suggest the relation between X, Y and Z



Experiment	Heat supplied	Work done	ΔE
I	100J Supplied to the system	200J done by the system	X Joules
II	200J Supplied to the system	200J done on the system	Y Joules
III	400J lost to the system	100J done by the system	Z Joules

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8. What are the values of w and ΔE, when a system absorbs 250J of heat by expanding from 1 lit to 10 lit against 0.5 atm pressure and at constant temperature.

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9. $C_{(\text{graphite})} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)}$,

$\Delta H = +131.4kJ$. (Assume reaction occures at STP) How much energy is absorbed when one litre of hydrogen gas is formed at STP ?

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10. $N_{2(g)} + O_{2(g)} + 180.6kJ \rightarrow 2NO_{(g)}$, calculate (a) heat of reaction, (b) heat of formation of nitric oxide and (c) heat required to form one litre of nitric oxide at $25^{\circ}C$.

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11. ΔH^0 for a reaction $F_2 + 2HCl \rightarrow 2HF + Cl_2$ is given as $-352.8kJ$. ΔH_f^0 for HF is $-268.3KJmol^{-1}$, then ΔH_f^0 of HCl would be

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12. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}, \Delta H = -286.2KJ$

$H_2O_{(l)} \rightarrow H^+_{(aq)} + OH^-_{(aq)}, \Delta H = +57.3KJ$

Enthalpy of ionization OH^- in aqueons solution is

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13. Calculate the value of $(\Delta H - \Delta E)$in calories for the combustion of CH_4 at $27^\circ C$.

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14. 19.5 g of benzene on burning in the free supply of oxygen liberated 126 kJ of energy at constant pressure. Calculate the enthalpy of combustion of benzene. Write the thermochemical equation.

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15. 4.184g of benzoic acid was burnt in bomb calorimeter. The rise in the temperature is 10°. The heat capacity of calorimeter and its contents is $2.644 kcal K^{-1}$. Calculate the heat of combustion of benzoic acid.

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16. $H_2SO_4(aq) + 2NaOH_{(aq)} \rightarrow Na_2SO_4(aq) + 2H_2O_{(l)}$. Suggest the hest of this reaction.

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17. $HCN_{(aq)} + NaOH_{(aq)} \rightarrow NaCN_{(aq)} + H_2O_{(l)}, DetlaH = -12.13kJ$. Calculate heat of ionisation of HCN.

View Text Solution

18. In the reaction between strong acid and strong base, 1.8 g of water is formed. The heat evolved is used to raise the temperature of one kg of water at $25^\circ C$. What is the final temperature of water?

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19. mole of same solute is dissolved in 200 moles of water 18.58 kJ of heat is absorbed. Calculate the enthalpy of dilution.

View Text Solution

20. The bond enthalpies of D-Dand O-O and D-O are respectively, $+440, \ +498$ and $+491.5kJmol^{-1}$. Calculate ΔH for the reaction $D_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow D_2O_{(l)}$

View Text Solution

21. ΔH for the formation of XY is $-200kJmol^{-1}$.The bond enthalpies of $X_2, Y_2,$ and XY are in the ratio 1:0.5:1. Then determine the bond enthalpies.

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22. Heats of combustion of graphite carbon and carbon monoxide are respectively $-393.5kJmol^{-1}$ and $-283kJmol^{-1}$. Calculate the heat of formation of carbon monoxide.

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23. The heat of transition of S_{α} into S_{β} is +2.5 kJ. The heat of combustion of monoclinic sulphur is $-300kJmol^{-1}$. Calculate heat of combustion of rhombic sulphur $\left(S_{\alpha}\right)$.

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24. Heats of combustion of benzene, carbon and hydrogen are $-782, -94, -68kcalmol^{-1}$ respectively. Calculate heat of formation of benzene.

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25. The heat of formation of crystalline sodium chloride is $-410 kJmol^{-1}$. The heat of sublimation of sodium metal is $180.8 kJmol^{-1}$. The heat of dissociation of chlorine gas into atoms is $242.7 kJmol^{-1}$. The ionisation energy of Na and electron affinity of Cl are $493.7 kJ$ and $-368.2 kJ$ respectively. Calculate the lattice energy of NaCl.

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26. The heats of formation of $CO_{2(g)}, H_2O_{(l)}$ and $CH_{4(g)}$ are respectively $-394 kJmol^{-1}$, $-286 kJmol^{-1}$ and $-76 kJmol^{-1}$. Calculate the heat of combustion of methane.

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27. The standard molar heat for formation of ethane, carbondioxide and water are respectively, -21.1,-94.1 and -68.3 Kacal mol^{-1}. What is the standard molar heat of combustion of ethane ?

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28. Latent heat of fusion of ice is $6 kJmol^{-1}$. Calculate the entropy change in the fusion of ice.

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29. The entropy change for vaporisation of a liquid is $109.3 JK^{-1}mol^{-1}$. The molar heat of vaporisation of that liquid is $40.77 kJmol^{-1}$. Calculate the boiling point of that liquid.

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30. Based on entropy Change predict a spontaneous reaction among the following.

$(A): \left(NH_4\right)_2CO_3(s) \rightarrow 2NH_3(g) + CO_2(g) + H_2O(l)$ and $(B): NH_3(g) + H_2S(g)$

.

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31. Calculate $DetlaG^{\circ}$ for the following reaction, $Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$. ΔG°_{f} of $Zn^{2+}_{(aq)}$ and $Cu^{+2}_{(aq)}$ is-147.2 kJ mol^(-1) and 65kJmol^(-1)` .

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32. The equilibrium constant of a reaction is 73. Calculate standard free energy change.

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33. The reaction, $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$, is spontaneous. The $\Delta S^{\circ} = -163.1 Jmol^{-1}K^{-1}$. The absolute entropies of $H_{2(g)}$ and $O_{2(g)}$ are $130.6 JK^{-1}mol^{-1}$ and $205 JK^{-1}mol^{-1}$ respectively. Calculate the absolute entropy of water.

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34. The standard free energy of $Cu^{+}_{(aq)}$ is $50kJmol^{-1}$ and that of $Cu^{2+}_{(aq)}$ is $66kJ.mol^{-1}$. Calculate the change in free energy for the reaction, $Cu^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + e^{-}$.

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35. $Zn_{(s)} + Fe^{2+}_{aq} \Leftrightarrow Zn^{2+}_{aq} + Fe_{(s)}$. The vale of $K_c$for this reaction is `10^(23). Calculate the standard free energy change.

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36. 1 g of graphite is burnt in a bomb calorimeter in excess of O_2 at 298 K and 1 atm. Pressure according to the equations.

$C_{\text{graphite}} + O_{2(g)} \rightarrow CO_{2(g)}$

During the reaction the temperature rises from 298 K to 200K. Heat capacity of the bomb calorimeter is $20.7KJK^{-1}$. What is the enthalpy change for the above reaction at 298 K 1 atm?

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37. What are the sign of the entropy change (+ or -) in the following:

I : A liquid crystallises into a solid

II: Temperature of a crystalline solid is raised from 0K to 115K

III: $2NaHCO_{3(g)} \rightarrow Na_2CO_{3(g)} + CO_{2(g)} + H_2O_{(g)}$

IV : $H_{2(g)} \rightarrow 2H_{(g)}$

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38. Kp for the reaction $\frac{3}{2}O_{2(g)} \overset{\rightarrow}{\leftarrow} O_{3(g)}$ at $25^{\circ}C$ is 2.47×10^{-29}. Then ΔG° for the conversion is

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39. A swimmer coming out from a pool is covered with a film of water weighing about 18g. How much heat must be supplied to evaporate this water at 298 K? Calculate the internal energy of vaporisation at $100^{\circ}C$. ΔH°_{vap} for water at $373K = 40.66kJmol^{-1}$

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40. Find out the value of equilibrium constant for the following reaction at 298 K.

`2NH_(3(g)) + CO_(2(g)) standard Gibbs energy change, ΔG° at the given temperature is $-13.6 kJmol^{-1}$.

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SUBJECTIVE EXERCISE- 1 (LONG ANSWER QUESTIONS)

1. What are the types of systems? Explain give one example each?

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2. State the first law of thermodynamics.

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SUBJECTIVE EXERCISE- 1 (SHORT ANSWER QUESTIONS)

1. What are intensive and extensive properties?

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2. Discuss on internal energy and enthalpy?

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3. Define heat capacity and molar heat capacity. How are C_p and C_v related?

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4. What is a thermochemical equation ? Write its significance.

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5. What does one mean by exothermic and endothermic reactions? Give examples.

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6. An ideal gas expands from $500cm^3$ to $700cm^3$ against 1 atm pressure, by absorbing 2J of energy. Calculate change in internal energy of the ideal gas.

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7. How are ΔH and ΔE are related for a gaseous equilibrium reaction ? What is (ΔH - ΔE) for $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$?

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8. Give the mathematical formulation of first law of thermodynamics.

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9. In a process 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in internal energy for the process?

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10. For an isolated system , $\Delta U = 0$ what will be ΔS?

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11. At 400K, 5 moles of an ideal gas expands isothermally and reversibly from $10 dm^3$ to $20 dm^3$. Calculate the work done by the gas.

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12. 0.14kg of nitrogen at 300K is expanded isothermally and reversibly until its volume becomes doubled. Calculate the work done by the gas.

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13. 0.096kg of oxygen is compressed iso thermally and reversibly from $10^5 N.M^{-2}$ to $2 \times 10^5 N.M^2$ at 300 K. Calculate the work done during the impression process.

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SUBJECTIVE EXERCISE- 1 (VERY SHORT ANSWER QUESTIONS)

1. Explain "system" and "surroundings".

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2. Name three intensive properties.

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3. What is heat capacity? Explain.

Watch Video Solution

4. What is a thermochemical equation ? Write its significance.

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SUBJECTIVE EXERCISE- 2 (LONG ANSWER QUESTIONS)

1. What is heat of a reaction? Discuss the factors on which it is dependent.

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2. What is heat of combustion ? How is it determined using bomb calorimeter ?

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3. State and explain Hess law. Write its important applications

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4. By using Born-Haber cycle to calculate the crystal lattice energy of NaCl, discuss the heats, involved in all the changes.

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SUBJECTIVE EXERCISE- 2 (SHORT ANSWER QUESTIONS)

1. Define heat of formation. Write suitable examples.

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2. Define heat of neutralisation. Write the basic equation. Why the heat liberated by the neutralisation of a weak acid is less than $57.3kJmol^{-1}$?

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3. What are C_p and C_v?

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4. Define Heat of solution. Give an example.

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5. When 2.4g of carbon reacted with X g of oxygen to form CO and CO_2, $50.4kJ$of heat was released and no reactant is left over.

Standard heats of formation of carbon monoxide and carbondioxide are $-110.5kJmol^{-1}$ and $-393.5kJmol^{-1}$ respectively. Calculate X.

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6. Heats of atomisation of chlorine and hydrogen are $243kJmol^{-1}$ and $435kJmol^{-1}$ respectively. Heat of formation of HCl is $-92kJmol^{-1}$. Calculate the bond energy of HCL.

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7. The bond energy of $H_{2(g)}$ is 436kJ/mole. The bond enthalpy of $N_{2(g)}$ is 941.3 kJ/mole. What is the bond enthalpy of N - H if NH_3 formation energy is -46.0 kJ/mole ?

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8. Calculate the number of kJ of heat necessary to rise the temperature of 60.0 g of aluminum from $35^\circ C \rightarrow 55^\circ C$. Molar heat capacity of aluminum is 24 J $mol^{-1}K^{-1}$.

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9. The reaction of cyanamide (s), with dioxygen was carried out in a bomb calorimeter and ΔU was found to be -742.7 kJ mol^{-1} at 298 K. Calculate the enthalpy change for the reaction at 298 K.

$$NH_2CN_{(g)} + \frac{3}{2}O_2(g) \rightarrow N_{2(g)} + CO_{2(g)} + H_2O_l$$

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10. The molar heat capacity at constant volume of a system is 12.41J. mol^{-1}. In an adiabatic expansion the temperature of one mole of that gas falls from 298K to 288K. Calculate the work done by the gas.

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11. Enthalpy of ammonia and water are $-46.19KJ.mol^{-1}$ and $-285.9KJ.mol^{-1}$. Calculate AH for the reaction, $4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(l)$.

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12. At constant pressure, the heat of combustion of carbon monoxide at 17^0C is –284.5 kJ. Calculate its heat of combustion at constant volume

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13. Calculate the difference between ΔE and ΔH values for the combustion reaction of ethylene at 300K

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14. The heats of combustion of hydrogen and cyclohexene are $-241 kJmol^{-1}$ and $-3800 kJmol^{-1}$.The heat of hydrogenation of cyclohexene is $-121 kJmol^{-1}$. Calculate the heat of combustion of cyclohexane.

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15. Heat of formation of water and heats of combustion of ethylene and acetylene are respectively $286, -1410$ and $-1299 kJmol^{-1}$, Calculate the heat of the reaction,

$C_2H_{2(g)} + H_{2(g)} \rightarrow C_2H_{4(g)}$.

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16. At 298K heats of formation of $H_2O_{(l)}, CO_{2(g)}, HCl_{(g)}$ and $CCl_{4(l)}$ are respectively $-241.8, -393.7, -92.5$ and $-106.7 kJmol^{-1}$. Calculate ΔH for the following reaction

$CCl_{4(l)} + 2H_2O_{(g)} \rightarrow CO_{2(g)} + 4HCl_{(g)}$

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SUBJECTIVE EXERCISE- 2 (VERY SHORT ANSWER QUESTIONS)

1. Heat of neutralisation of $CH_3COOH_{(aq)}$ with $NaOH_{(aq)}$ is - 55.2kJ. What is heat of ionisation of CH_3COOH ?

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2. Heats of ionisation of acetic acid and ammonium hydroxide are $xkJmol^{-1}$ and $ykJmol^{-1}$. Heat of neutralisation of HCl and NaOH is $zkJmol^{-1}$. Calculate the heat when acetic acid is neutralised with ammonium hydroxide. $\left(z-(x+y)kJmol^{-1}\right)$

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3. 500mL of IM HCl and 500mL of 1M NaOH are mixed in Dewar flask. Then rise in temperature is T_1. In another experiment

$1000 mL 1 M HCl$ and $1000 mL of 1 M NaOH$ are mixed in Dewar flask. Then rise in temperature is T_2. What is the relation between T_1 and T_2 ?

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SUBJECTIVE EXERCISE- 3 (SHORT ANSWER QUESTIONS)

1. Discuss the following:

(a) entropy and (b) entropy change.

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2. State the second law of thermodynamics in any two ways.

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3. Explain whether a reaction occurs on its own, by considering the entropy change of the reaction.

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4. The absolute entropies of $H_{2(g)}, O_{2(g)}$ and $H_2O_{(l)}$ are respectively $130.6, 205.1$ and $69.9JK - mol^{-1}$. Calculate the value of ΔS for the formation of one mole liquid water.

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SUBJECTIVE EXERCISE- 3 (VERY SHORT ANSWER QUESTIONS)

1. Give the order of entropies of solid, liquid and gas.

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2. Give the units of entropy and entropy change.

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3. Calculate ΔS of water at its melting point.

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SUBJECTIVE EXERCISE- 4 (LONG ANSWER QUESTIONS)

1. Explain Gibbs energy, enthalpy, entropy.

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SUBJECTIVE EXERCISE- 4 (SHORT ANSWER QUESTIONS)

1. Define Gibbs energy. How is it related to enthalpy and entropy?

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2. What are the criteria for the spontaneity of chemical reaction?

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3. State the third law of thermodynamics.

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4. At 300K, heat of dissociation of lime stone is $+180kJmol^{-1}$. Entropies of $CaCO_3, CaO$ and Co_2 are respectively $93, 39$ and $213Jmol^{-1}K^{-1}$. Calculate ΔS_{total}

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5. $4Fe(s) + 3O_{2(g)} \rightarrow 2Fe_2O_3(g)$. The value of ΔS is $-550JK^{-1}$ and the value of DH is $-1650kJ$ at 298 K. Does the process is spontaneous or not?

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6. For the equilibrium , $2NOCl(g) \Leftrightarrow 2NO(g) + Cl_2(g)$ the value of the equilibrium constant, K_c is 3.75×10^{-6} at $1069K$. Calculate the K_p for the reaction at this temperature ?

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7. For the reaction at 298 K,

$2A + B \rightarrow C$

$\Delta H = 400 kJ mol^{-1}$ and $\Delta S = 0.2 kJ K^{-1} mol^{-1}$.

At what temperature will the reaction becomes spontaneous considering ΔH and ΔS to be constant over the temperature range?

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8. The e.m.f. of the cell reaction

$Zn_{(s)} + Cu^{+2}_{(aq)} \rightarrow Zn^{+2}_{(aq)} + Cu_{(s)}$ is 1.1 V. Calculate the free energy of the cell reaction.

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9. For the reaction,

$2A(g) + B(g) \rightarrow 2D(g)$

$\Delta U^{\theta} = -10.5kJ$ and $\Delta S^{\theta} = -44.1JK^{-1}$

Calculate ΔG^{θ} for the reaction, and predict whether the reaction can occur spontaneously or not.

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10. The equilibrium constant for a reaction is 10. What will be the value of ΔG?

$R = 8.314JK^{-1}mol^{-1}, T = 300K.$

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11. Calculate the entropy change in surroundings when 1.00 mole of $H_2O_{(l)}$ is formed under standard conditions $\Delta_f H^{\theta} = -286kJmol^{-1}$.

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12. At $60^{\circ}C$ dinitrogen tetroxide is fifty percent dissociated. Calculate the standard free energy change at this temperature and at one atmosphere.

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13.

$H_2 + Cl_2 \rightarrow 2HCl, \Delta H_1, N_2 + 3H_2 \rightarrow 2NH_3, \Delta H_2$ and $NH_3 + 3Cl_2 \rightarrow NCl_3 + 3$

. Then calculate the heat of formation of nitrogen trichloride.

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14. At $427^{\circ}C$, for a given change the values of ΔG and ΔH are $-11, 500 Jmol^{-1}$ and $-11, 300 Jmol^{-1}$ respectively. Calculate the value of ΔS

.

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15. The reaction$A + B \Leftrightarrow C$ has the value of ΔH and value of ΔS respectively -12.52kJ and $313 J mol^{-1} K^{-1}$.At What temperature the reaction attains equilibrium state.

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SUBJECTIVE EXERCISE- 4 (VERY SHORT ANSWER QUESTIONS)

1. Give Gibbs Equation.

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2. Give Debye equation.

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3. Define Nernst heat theorem.

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4. Define free energy.

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5. Suggest the spontaneity for the thermal decomposition of lime stone and discuss.

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OBJECTIVE EXERCISE - 1 (THERMODYNAMIC TERMS, FIRST LAW)

1. Which of the following come under the view of thermodynamics?

A. Predicting the feasibility of chemical change

B. Predicting the extent of completion of the chemical change

C. Rate at which chemical change occurs at particular set of conditions

D. Effect of temperature on the rate of reaction

Answer: A

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2. An isolated system is that in which:

A. There is no exchange of energy with the surroundings

B. There is exchange of mass and energy with the surroundings

C. There is no exchange of mass and energy with the surroundings

D. There is exchange of mass with the sourroundings

Answer: C

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3. A well stoppered thermos flask contains some ice cubes. This is an example of

A. Closed system

B. Open system

C. Isolated system

D. Non-thermodynamic system

Answer: C

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4. A system which can exchange energy with the surrounding but not matter is called

A. A heterogeneous system

B. An open system

C. A closed system

D. An isolated system

Answer: C

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5. An intensive property of theromdynamics means a property which depends

A. On the amount of the substance only

B. On the nature of the substance only

C. Both on the amount as well as nature of the substance

D. Neither on the amount nor on the nature

Answer: B

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6. The intensive property among these quantities is

A. Mass

B. Density

C. Enthalpy

D. Volume

Answer: B

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7. Which is an extensive property of the system?

A. Volume

B. Viscosity

C. Temperature

D. Refractive index

Answer: A

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8. In which of the following sets, all the properties belong to same category (all extensive or all intensive)

A. Mass, volume, specific heat

B. Temperature, pressure, volume

C. Heat capacity, density, entropy

D. Enthalpy, internal energy, volume

Answer: D

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9. Which of the following statements is correct?

A. Only internal energy is a state function but not work

B. Only work is a state function but not internal energy

C. Both internal energy and work are state functions

D. Neither internal energy nor work is a state function

Answer: A

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10. Which of the following statement is false ?

A. Work is a state function

B. Temperature is a state function

C. Change of state is completely defined when initial and final states are specified

D. Work appears at the boundary of the system

Answer: A

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11. A process in which no heat change takes place is called

A. An isothermal process

B. An adiabatic process

C. An isobaric process

D. An isochoric process

Answer: B

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12. A gaseous system changes from state $A(P_1, V_1, T_1)$ to $B(P_2, V_2, T_2)$, B to $C(P_3, V_3, T_3)$ and finally from C to A. The whole process may be called

A. Reversible process

B. Cyclic process

C. Isobaric process

D. Spontaneous process

Answer: B

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13. A gas expands isothermally and reversibly. The work done by the gas is

A. Zero

B. Maximum

C. Minimum

D. Not known

Answer: B

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14. In an adiabatic expansion of ideal gas:

A. Increase in temperature

B. $q = 0$

C. $W = 0$

D. $\Delta E = 0$

Answer: B

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15. Which among the following gives the expression for work done by ideal gas ?

A. $-P\Delta V$

B. $-nRT\ln\frac{V_2}{V_1}$

C. Both 1 and 2

D. Neither 1 nor 2

Answer: C

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16. What is correct about isothermal expansion of the ideal gas ?

A. $W_{rev} = W_{irr}$

B. $W_{rev} + W_{irr} = 0$

C. $W_{rev} > W_{irr}$

D. $q_{rev} = q_{irr}$

Answer: C

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17. In thermodynamics, a process is called reversible when

A. Surroundings and system change into each other

B. There is no boundary between system and surroundings

C. Surroundings are always in equilibrium with system

D. System changes into surroundings spontaneously

Answer: C

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18. In an adiabatic expansion of ideal gas:

A. $\Delta E = W$

B. $\Delta E$is maximum

C. $\Delta E = 0$

D. dq is maximum

Answer: A

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19. A heat engine absorbs heat q_1 from a source at temperature T_1 and heat q_2 from a source at temperature T_2. Work done is found to be $J(q_1 + q_2)$. This is in accordance with

A. Violates 1st law of thermodynamics

B. Violates 1st law of thermodynamics if Q_1 is negative

C. Violates 1st law of thermodynamics if Q_2 is negative

D. Does not violate first law of thermodynamics

Answer: D

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20. Two moles of an ideal gas is expanded isothermally and reversibly from 1 litre to 10 litre at 300 K. The internal energy change (in kJ) for the process (R = 8.3J)

A. 11.4 KJ

B. - $11.4KJ$

C. $0KJ$

D. $-4.8KJ$

Answer: C

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21. During adiabatic expansion of an ideal gas, 100J work is done, ΔE of system is

A. Zero

B. 100J

C. 200J

D. - $100J$

Answer: D

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22. On which of the following factors does internal energy depend upon

A. Mass of the system

B. Temperature of the system

C. Nature of the system

D. All the above

Answer: D

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23. For a substance more internal energy is observed in [same quantity]

A. Solid state

B. Liquid state

C. Gaseous state

D. All have same

Answer: C

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24. The total heat content of a system at constant pressure is

A. Enthalpy

B. Interanl energy

C. Entropy

D. Free energy

Answer: A

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25. Enthalpy "H" can be given as

A. $H = E - PV$

B. $H = E + PV$

C. $H = E + P + V$

D. $H = E - TS$

Answer: B

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26. The enthalpy is maximum for

A. 10 gms of water

B. 10 gms of ice

C. 10 gms of steam

D. Same for all

Answer: C

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27. The expression $[\Delta E / \Delta T]_V$ represent

A. Heat capacity at constant volume

B. Heat capacity at constant pressure

C. Enthalpy change

D. Eantropy change

Answer: A

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28. The heat of reaction at constant volume and temperature is represented by

A. ΔE

B. ΔH

C. ΔP

D. ΔV

Answer: A

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29. Which of the following relationships is correct for a reaction involving both reactants and products both in either solid or liquid state?

A. $\Delta H > \Delta E$

B. $\Delta H = \Delta E$

C. $\Delta H < \Delta E$

D. $\Delta H - \Delta E = \infty$

Answer: B

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30. The different between ΔH and ΔE for the reaction $BaCl_{2(aq)} + K_2SO_{4(aq)} \rightarrow BaSO_{4(s)} \downarrow + 2KCl_{(aq)}$

A. RT

B. 2RT

C. (1/2)RT

D. Zero

Answer: D

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31. For which one of the following systems $DE < DH$

A. $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

B. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

C. $2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$

D. $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$

Answer: C

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32. When a reaction is conducted in an open vessel, the heat of reaction is represented as

A. ΔH

B. ΔE

C. $P\Delta V$

D. ΔnRT

Answer: A

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33. Which of the following holds good to the laws of thermodynamics for the reaction ?

$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)}$

A. $\Delta H = \Delta E + RT$

B. $\Delta H = \Delta E - RT$

C. $\Delta H = \Delta E + 2RT$

D. $\Delta H = \Delta E - 2RT$

Answer: D

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34. For which of the following reaction $\Delta H = \Delta E + 2RT$

A. $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

B. $NH_4HS_{(s)} \rightarrow NH_{3(g)} + H_2S_{(g)}$

C. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

D. $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

Answer: B

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35. For $N_2 + 3H_2 \rightarrow 2NH_3$, enthalpy and internal energy changes respectively are, $\Delta H \ \& \ \Delta U$ then

A. $\Delta H = 0$

B. $\Delta H \Delta U$

C. $\Delta H < \Delta U$

D. $\Delta H > \Delta U$

Answer: C

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36. According to IUPAC conventions, which one of the following is/are correct?

A. The heat absorbed by a system is taken as positive

B. If a system is accompained by decrease in energy, $\Delta E$is negative

C. The work done by the system is taken as negative

D. All the above three statements are correct

Answer: D

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37. During expansion of a gas into vaccum $\left(P_{\text{ext}} = 0\right)$, Work done is zero if the process is

(A) Reversible (B) Irreversible (C) Isothermal

A. A, B & C are true

B. A, B & C are false

C. A & C are true

D. B & C are false

Answer: A

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38. Give the mathematical formulation of first law of thermodynamics.

A. $C_v = aT^3$

B. $\Delta S_{\text{total}} = \Delta S_{sys} + \Delta S_{sur}$

C. $q = \Delta U + W$

D. $\Delta S_{sys} = \frac{qrev}{T}$

Answer: C

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39. A system absorbs 'xJ' heat and does "yJ" work. Its ΔE is +Ve when

A. $y > x$

B. $x > y$

C. $y = 2x$

D. $x = y$

Answer: B

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40. In an adiabatic expansion of ideal gas:

A. $W = -\Delta E$

B. $W = \Delta E$

C. $\Delta E = 0$

D. $W = 0$

Answer: A

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41. During isothermal expansion of an ideal gas, its internal energy

A. Decreases

B. Increases

C. May increase or decrease

D. Remain unchanged

Answer: D

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42. For the gaseous reaction involving the complete combustion of isobutane

A. $\Delta H = \Delta E$

B. $\Delta H > \Delta E$

C. $\Delta H = \Delta E = 0$

D. $\Delta H < \Delta E$

Answer: D

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43. Which of the one following is not a state function ?

A. Internal energy

B. Work

C. Entropy

D. Free energy

Answer: B

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44. Which of one following is applicable is applicable for an adiabatic expansion of an ideal gas?

A. $\Delta E = 0$

B. $\Delta W = \Delta E$

C. $\Delta W = -\Delta E$

D. $\Delta W = 0$

Answer: B::C

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45. At $27^{\circ}C$, one mole of an ideal gas ocmpressed isothermally and reversibly from a pressure of 2 atm to 1.0 atm, Choose the correct option from the following

A. Change in internal energy is positive

B. Heat is negative

C. Work done is $-965, 84$cal

D. All are incorrect

Answer: B

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OBJECTIVE EXERCISE - 1 (EXOTHERMIC AND ENDOTHERMIC REACTIONS)

1. Which of the following reaction do you think will result in the absorption of heat ?

A. Carbon burning in air

B. Iron reacting with sulphur to form iron sulphide

C. Formation of water gas from steam and coke

D. Formation of producer gas

Answer: C

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2. The formation of water from $H_{2(g)}$ and $O_{2(g)}$ is an exothermic reaction because

A. $H_{2(g)}$ and $O_{2(g)}$ have a higher chemical energy than water

B. $H_{2(g)}$ and $O_{2(g)}$ have a lower chemical energy than water

C. $H_{2(g)}$ and $O_{2(g)}$ have a higher temperature than water

D. Energy considerations does not arise

Answer: A

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3. When a solid melts there is

A. An increase in enthalpy

B. A decrease in enthalpy

C. No change in enthaply

D. A decrease in internal energy

Answer: A

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4. Assertion(A): The enthalpies of elements in their standard states are taken as zero

Reason (R): It is impossible to determine the absolute enthalpy of any substance

A. Both A and R are true R is the correct explanation.

B. Both A and R are true R is not the correct explanation.

C. A is true but R is false

D. A is false but R is true

Answer: B

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5. (A): The heat absorbed during isothermal expansion of an ideal gas against vacuum is zero.

(R): The volume occupied by the molecules is zero.

A. Both A and R are true R is the correct explanation.

B. Both A and R are true R is not the correct explanation.

C. A is true but R is false

D. A is false but R is true

Answer: C

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6. In exothermic reaction

A. $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}, \Delta H = -184.6KJ$

B. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}, \Delta H = +180.8KJ$

C. $C_{(\text{graphite})} + H_2O_{(g)} \rightarrow CO_2 + H_{2(g)} - 131.4KJ$

D. $C_{(\text{graphite})} + 2S_{(g)} + 91.9KJ \rightarrow CS_{2(l)}$

Answer: A

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7. Which are of the following is an exothermic reaction?

A. $N_{2(g)} + O_{2(g)} + 180.8k.J \rightarrow 2NO_{(g)}$

B. $N_{2(g)} + 3H_{2(g)} - 92k.J \rightarrow 2NH_{3(g)}$

C. $C_{(\text{graphite})} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)} - 131.3KJ$

D. $C_{(\text{graphite})} + 2S_{(g)} \rightarrow CS_{2(l)} - 91.9k.J$

Answer: B

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8. Which of the following is an endothemic reaction?

A. $N_{2(g)} + 3H_{2(g)} - 92KJ \rightarrow 2NH_{3(g)}$

B. $N_{2(g)} + O_{2(g)} + 180.8KJ \rightarrow 2NO_{(g)}$

C. $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}, \Delta H = -184.6kJ$

D. $C_{(\text{graphite})} + 2H_{2(s)} \rightarrow CH_{4(g)} + 74.8k. J.$

Answer: B

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OBJECTIVE EXERCISE - 1 (HEAT OF FORMATION)

1. (A): Enthalpy of graphite is lower than that of diamond.

(R): Entropy of graphite is greater than that of diamond.

A. Both A and R are true R is the correct explanation.

B. Both A and R are true R is not the correct explanation.

C. A is true but R is false

D. A is false but R is true

Answer: B

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2. Which of the following reactions represents ΔH_f°

A. $C_{(\text{diamond})} + O_{2(g)} \rightarrow CO_{2(g)}$

B. $\frac{1}{2}H_{2(g)} + \frac{1}{2}F_{2(g)} \rightarrow HF_{(g)}$

C. $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

D. $CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$

Answer: B

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3. Which of the following equation represents standard heat of formation of ethanol?

A. $CH_3CHO_{(l)} + \frac{1}{2}H_{2(g)} \xrightarrow{Ni} C_2H_5OH_{(l)}$

B. $2C_{(\text{graphite})} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(g)}$

C. $2C_{(\text{diamond})} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(g)}$

D. $2C_{(\text{graphite})} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(l)}$

Answer: D

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4. The reaction which shows standard heat of formation of water correctly is

A. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}, \Delta H = -68.3kcal$

B. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(s)}, \Delta H = -68.3kcal$

C. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}, \Delta H = -68.3kcal$

D. $2H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow 2H_2O_{(l)}, \Delta H = -136.6kcal$

Answer: A

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5. The enthalpy of the reaction

$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(g)}$ is ΔH_1 and that of $H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(l)}$ is

ΔH_2. Then

A. $\Delta H_1 < DetlaH_2$

B. $\Delta H_1 + \Delta H_2 = 0$

C. $\Delta H_1 > \Delta H_2$

D. $\Delta H_1 = \Delta H_2$

Answer: A

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6. The enthalpies of elements under the following conditions are assumed to be

A. Zero at 298 K and 1 atm

B. Unit at 298 K and 1 atm

C. Zero at 273 K and 1 atm

D. Unity at 273 K and 1 atm

Answer: A

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7. For which of the following elements, the standard enthalpy is not zero?

A. C (Diamond)

B. C (Graphite)

C. Liquid mercury

D. Rhombic sulphur

Answer: A

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8. The enthalpy of elements in their standard states are taken as zero. Hence the enthalpy of formation of a compound is

A. always negative

B. always positive

C. positive (or) negative

D. equal to zero

Answer: C

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9. Identify the reaction in which the heat liberated corresponds to the heat of formation $\left(\Delta H_f\right)$:

A. $C_{(\text{diamond})} + O_{2(g)} \rightarrow CO_{2(g)} + \text{heat}$

B. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)} + \text{heat}$

C. $C_{(\text{diamond})} + O_{2(g)} \rightarrow CII_{4(g)} + \text{heat}$

D. $S_{(\text{rhombic})} + O_{2(g)} \rightarrow SO_{2(g)} + \text{heat}$

Answer: D

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10. The heat change for the following reaction $C_{(s)} + 2S_{(s)} \to CS_{2(l)}$ is known as

A. Heat of formation of CS_2

B. Heat of fusion of CS_2

C. Heat of vapourisation of CS_2

D. Heat of transition of Carbon

Answer: A

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11. In which of the following reactions heat liberated is known as standard heat of formation of CO_2?

A. $2CO_{(g)} + O_{2(g)} \to 2CO_{2(g)}, \Delta H = -135.6kcals$

B. $C_{(\text{diamond})} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -94.5 kcals$

C. $C_{(\text{graphite})} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -94.05 kcals$

D. $CH_{4(g)} + 2O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)}, \Delta H = -2128 kcals.$

Answer: C

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12. The chemical process involved in the combustion reactions is

A. Oxidation

B. Reduction

C. Redox reaction

D. Disproportionation reaction

Answer: C

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13. Which of the following is not a combustion reaction

A. $CO + \frac{1}{2}O_2 \rightarrow CO_2$

B. $C + O_2 \rightarrow CO_2$

C. $C + \frac{1}{2}O_2 \rightarrow CO$

D. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Answer: C

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14. $C_{\text{graphite}} + O_{2(g)} : \Delta H = - 393.5kJ. \Delta H$ of the above reaction cannot be

A. Heat of formation of CO_2

B. Heat of combustion of C

C. Heat of reaction

D. Heat of transition

Answer: D

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OBJECTIVE EXERCISE - 1 (HEAT OF NEUTRILIZATION)

1. (A): The enthalpy of neutralisation of a strong acid by a strong base is a constant.

(R) : The net reaction that takes place is the same.

A. Both A and R are true R is the correct explanation.

B. Both A and R are true R is not the correct explanation.

C. A is true but R is false

D. A is false but R is true

Answer: A

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2. For the following reaction $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}, \Delta H = -Q$, where ΔH represents

A. Heat of formation

B. Heat of combustion

C. Heat of neutrilisation

D. Heat of dilution

Answer: C

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3. Enthalpy of neutralisation of all strong acids and strong bases has the same value because

A. Neutralisation leads to the formation of a salt and water

B. Strong acid and bases are ionic substances

C. Acids always furnish H^+ ions and bases always furnish OH^- ions

D. The net chemical change involes the combination of 1 mol of H^{+} ions and 1 mol OH^{-} ions to form water.

Answer: D

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4. The heat of neutralisation is maximum when

A. Sodium hydroxide is neutralised by acetic acid

B. Ammonium hydroxide is neutralised by acetic acid

C. Ammonium hydroxide is neutralised by hydrochloric acid

D. Sodium hydroxide is neutralised by hydrochloric acid. Other heats of reactions

Answer: D

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OBJECTIVE EXERCISE - 1 (OTHER HEATS OF REACTIONS)

1. The standard enthalpy of formation $\left(\Delta H^0\right)$ at 298K for methane, $CH_{4(g)}$ is 74.8 $kJmol^1$. The additional information required to determine the average energy for C-H bond formation would be

A. The dissociation energy of hydrogen molecule, H_2

B. The dissociation energy of H_2 and enthalpy of sublimation of carbon

C. Latent heat of vaporisation of methane.

D. The first four ionisation energies of carbon and electron gain enthalpy of hydrogen

Answer: B

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2. For the transition $C_{(\text{diamonid})} \rightarrow C_{(\text{graphite})}, \Delta H = -1.5KJ$. It follows that

A. Graphite is stabler than diamond

B. Diamond is stabler than graphite

C. Graphite is endothermic substance

D. Diamond is exothermic substance

Answer: A

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3. Which of the following is not correct ?

A. Dissolution of NH_2Cl in excess of water is an endothermic process

B. Neutralisation process is always exothermic

C. The absolute value of enthalpy (H) can be determined experimentally

D. The heat of reaction at constant volume is denoted by ΔE

Answer: C

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4. (A): The Mass, volume and pressure are extensive properties.

(R): Extensive properties depend upon the amount of the substance.

A. Both A and R are true and R is the correct explanation

B. Both A and R are true but R is not the correct explanation of A

C. A is true but R iş false

D. A is false but R is true

Answer: A

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5. $MgSO_{4(s)} + H_2O \rightarrow MgSO_{4(aq)}, \Delta H =$ - $84K$. Cals, ΔH of the reaction is known as

A. Heat of dilution

B. Heat of solution

C. Heat of fusion

D. Heat of transition

Answer: B

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6. Dissolution of which of the following in water is endothermic ?

A. $NaOH$

B. Na_2CO_3

C. $MgSO_4$

D. NH_4Cl

Answer: D

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7. The enthalpy change for the process $C_{(\text{graphite})} \rightarrow C(g), \Delta H = +xKJ$ represents enthalpy of

A. Fusion

B. Sublimation

C. Combustion

D. Vapourisation

Answer: B

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OBJECTIVE EXERCISE - 1 (HESS LAW)

1. Hess.s law is based on

A. Law of conservation of mass

B. Gibb.s equation

C. First law of thermodynamics

D. Kirchoff.s equation

Answer: C

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2. In which of the following equations ΔH^0 reaction equal to ΔH_f^0 for the product?

A. $2CO_{2(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$

B. $N_{2(g)} + O_{3(g)} \rightarrow N_2O_{3(g)}$

C. $CH_{4(g)} + 2Cl_{2(g)} \rightarrow CH_2Cl_2(l) + 2HCl_{(g)}$

D. $Xe_{(g)} + 2F_{2(g)} \rightarrow XeF_{4(g)}$

Answer: D

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3. Hess's law states that

A. The standard enthalpy of an overall reaction is the sum of the enthalpy chages in individual reactions.

B. enthalpy of formation of compoud is same as the enthalpy of decomposition of the compound into constituent elements, but with opposite sign

C. at constant temperature the pressure of a gas in inversely proportional to its volume.

D. the mass of a gas dissolved per lit of a solvent is proportional to the pressure of the gas in equilibrium with the solution.

Answer: A

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4. Heat of reaction (ΔH) is given by

A. ΔH = Activation energy of forward reaction - Activation energy of backward reaction

B. ΔH = Sum of bond energy of reactants - Sum of bond energy of products

C. ΔH = Sum of enthalpy of products - Sum of enthalpy of reactants

D. All the above

Answer: D

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5. The factor which does not influence that heat of the reaction is

A. Pressure

B. Temperature

C. Physical state of substance

D. Number of steps involved in the reaction

Answer: D

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OBJECTIVE EXERCISE - 1 (ENTORPY AND GIBBS ENERGY)

1. 1^{st} law does not tell about

A. Law of conservation of energy

B. Workdone whether +ve (or) – ve

C. Feasibility of a process

D. ΔE at constent T

Answer: C

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2. For change in entropy, units are

A. mol/lit

B. $mol. \ lit^{-1}\text{sec}^{-1}$

C. $J. \ mol^{-1}K^{-1}$

D. s^{-1}

Answer: C

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3. In standard state the non spontaneous reaction among the following is

A. Melting of ice

B. Natural radioactivity

C. Freezing of water

D. Rusting of iron

Answer: C

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4. The incorrect statement according to second law of themodynamics is

A. Heat cannot flow from colder body to a hotter body of its own

B. All spontaneous processes are themo dynamically irreversible

C. Heat can be converted into work completely without casusing some permanent change in the system (or) surroundings

D. Perpetual motion machine of second kind is not possible

Answer: C

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5. Incorrect statement related to an irreversible process is

A. Entropy of the universe goes on increasing

B. Gibbs energy of the system goes on decreasing

C. Total energy of the universe goes on decreasing

D. Total energy of the universe remains constant

Answer: C

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6. False statement regarding second law of thermodynamics is

A. It is impossible to construct a machine working in cycles which transforms heat from a lower temperature region to higher temperature region without intervention of any external agency.

B. Heat cannot flow from a colder body to a hotter body on its own

C. Any spontaneous process taking place in isolated system, $\Delta S < O$

D. All spontaneous processes are thermo dynamically irreversible and entropy of the system increases in all spontaneous processes.

Answer: C

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7. Entropy of a system depends upon

A. Volume

B. Temperature

C. Pressure

D. All

Answer: D

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8. One of the following reactions involves in decrease of entropy

A. Sublimation of dry ice

B. Crystallisation of salt from brine (aq)

C. Burning of rocket fuel

D. Decomposition of gaseous N_2O_4

Answer: B

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9. The least random state of H_2O system is

A. Ice

B. Liquid water

C. Steam

D. Same in all.

Answer: A

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10. For the reaction $I_{2(g)} \Leftrightarrow I_{2(s)}, \Delta H = -ve$. Then choose the correct statement from the following

(A) The process is spontaneous at all temperature

(B) The process is accompained by an increase in entropy

(C) The process is accompained by a decrease in entropy

(D) The process is accompained by a decrease in enthalpy

A. a, b and c

B. b and d

C. c and d

D. a, c and d

Answer: C

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11. Which of the following process has negative value of ΔS?

A. Dissolution of sugar in water

B. Stretching of rubber band

C. Decomposition of lime stone

D. Evaporation of water

Answer: B

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12. For a spontaneous process, in a reaction

A. $\Delta S_{\text{total}} = \left(\Delta S_{\text{system}} + \Delta S_{\text{surroundings}}\right) < 0$

B. $\Delta S_{\text{total}} = \left(\Delta S_{\text{system}} + \Delta S_{\text{surroundings}}\right) = 0$

C. $\Delta S_{\text{total}} = \left(\Delta S_{\text{system}} + \Delta S_{\text{surroundings}}\right) > 0$

D. $\Delta S_{\text{sys}} > \text{only}$

Answer: C

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13. Some statements are given with regard to entropy. The incorrect statement(s) are

(A) The absolute entropy of substances cannot be determined

(B) In standard state entropy of elements is always positive

(C) The entropy of universe always decreases

(D) In a spontaneous process, for an isolated system the entropy of the system generally increases

A. A, B

B. B, C

C. A,C

D. Only C

Answer: C

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14. For an irreversible process, the value of $\left[\Delta S_{(\text{system})} + \Delta S_{(\text{surroundings})}\right]$ is

A. > 0

B. < 0

C. 0

D. $2\Delta S_{(\text{surr})}$

Answer: A

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15. A process is spontaneous at all temperatures when

A. $\Delta H = \text{ - } ve, \Delta S = \text{ - } ve$

B. $\Delta H = \text{ + } ve, \Delta S = \text{ - } ve$

C. $\Delta H = \text{ - } ve, \Delta S = \text{ + } ve$

D. $\Delta H = +ve, \Delta S = +ve$

Answer: C

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16. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}, \Delta H = -ve$ and $\Delta G = -ve.$ Then the reaction is

A. Spontaneous and instantaneous

B. Spontaneous and endothermic

C. Spontaneous and slow

D. Non spontaneous and slow

Answer: C

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17. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}, \Delta H = -ve$ and $\Delta G = -ve$ then the reaction is

A. Spontaneous and instantaneous

B. Spontaneous and endothermic

C. Spontaneous and slow

D. Non spontaneous and slow

Answer: A

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18. Among the following what is necessary condition for spontanity of a process?

A. $DetlaS > 0$

B. $\Delta E < 0$

C. $\Delta H < 0$

D. $\Delta G < 0$

Answer: D

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19. Which of the following is the condition for a non spontaneous reaction at high temperature but spontaneous at low temperature ?

A. $\begin{array}{cc}\Delta H & \Delta S \\ - & - \end{array}$

B. $\begin{array}{cc}\Delta H & \Delta S \\ + & + \end{array}$

C. $\begin{array}{cc}\Delta H & \Delta S \\ + & - \end{array}$

D. $\begin{array}{cc}\Delta H & \Delta S \\ - & + \end{array}$

Answer: A

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20. Based on the third law of themodynamics, the entropy can be obtained using the equation.

A. $\Delta S = \frac{\Delta H}{T}$

B. $\int_0^T T.\, C_P^{-1} dT = S$

C. $\Delta G = T\Delta S$

D. $\int_0^T C_P T^{-1}$

Answer: D

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21. A chemical reaction cannot occur at all if its

A. ΔH is (+)ve and ΔS is (-)ve

B. ΔH is (-)ve and ΔS is (+)ve

C. ΔH and ΔS are (+)ve but $\Delta H < T\Delta S$

D. ΔH and ΔS are (-)ve but DeltaH gt TDeltaS`

Answer: A

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22. An equilibrium reaction $X + Y \Leftrightarrow W + Z, \Delta H = +ve$ is spontaneous in the forward direction. Then corresponding sign of ΔG and ΔS should be respectively

A. $+ve, -ve$

B. $-ve, +ve$

C. $+ve, +ve$

D. $-ve, -ve$

Answer: B

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23. For the process Dry ice $\rightarrow CO_{2(g)}$

A. ΔH is positive and ΔS is negative

B. Both ΔH and ΔS are negative

C. Both ΔH and ΔS are positive

D. ΔH is negative whereas ΔS is positive

Answer: C

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24. For which of the process, ΔS is negative?

A. $H_{2(g)} \rightarrow 2H_{(g)}$

B. $N_{2(g)}(1atm) \rightarrow N_{2(g)}(8atm)$

C. $2SO_{3(g)} \rightarrow 2SO_{2(g)} + O_{2(g)}$

D. $C_{\text{(diamond)}} \rightarrow C_{\text{(graphite)}}$

Answer: B

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25. The process of evaporation of a liquid is accompanised by

(A) Increase in enthalpy (B) Increase in entropy (C) Decrease in Gibbs energy

The correct statement(s) is/are

A. Only a and c

B. Only b and c

C. Only a and b

D. All

Answer: D

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26. The favourable conditions for a spontaneous reaction are

A. $T\Delta S > \Delta H, \Delta H = +ve, \Delta S = +ve$

B. $T\Delta S > \Delta H, \Delta H = +ve, \Delta S = -ve$

C. $T\Delta S = \Delta H, \Delta H = +ve, \Delta S = -ve$

D. $T\Delta S = \Delta H, \Delta H = +ve, \Delta S = +ve$

Answer: A

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27. A reaction has both DH and DS negative. The rate of reaction

A. Increases with increase of temperature

B. Increases with decrease of temperature

C. Remains unaffected by change of temperature

D. Cannot be predicted for change in temperature

Answer: A

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28. At $27\,^{\circ}C$ the reaction,

$C_6H_{6(l)} + \frac{15}{2}O_{2(g)} \rightarrow 6CO_{2(g)} + 3H_2O((l))$ proceeds spontaneously because the magnitude of

A. $\Delta H = T\Delta S$

B. $\Delta H > T\Delta S$

C. $\Delta H < T\Delta S$

D. $\Delta H > 0$ and $T\Delta S < 0$

Answer: B

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29. Although the dissolution of ammonium chloride in water is an endothermic reaction, even then it is spontaneous because

A. ΔH is positive, ΔS is negative

B. ΔH is positive, as is zero

C. ΔH is positive, $T\Delta S < \Delta H$

D. ΔH is positive, ΔS is positive and $\Delta H < T\Delta S$

Answer: D

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30. For the precipitation reaction of Ag^{+} ions with NaCl, which of the following statements is correct?

A. ΔH for the reaction is zero

B. ΔG for the reaction is zero

C. ΔG for the reaction is negative

D. $\Delta G = \Delta H$

Answer: C

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31. Which one of the following has ΔS^0 greater than zero?

A. $CaO_{(s)} + CO_{2(g)} < \Rightarrow CaCO_{3(s)}$

B. $NaCl_{(aq)} < \Rightarrow NaCl_{(s)}$

C. $NaNO_{3(s)} < \Rightarrow Na^{+}_{(aq)} + NO^{-}_{3(aq)}$

D. $N_{2(g)} + 3H_{2(g)} < \Rightarrow 2NH_{3(g)}$

Answer: C

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32. What of the following relationship is correct?

A. $\Delta G^{\circ} = -RT\ln K$

B. $K = e^{-\Delta G^{\circ}/RT}$

C. $K = 10^{-\Delta G^{\circ}/2.303RT}$

D. All are correct

Answer: D

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33. For a reaction $R_1, \Delta G = xKJmol^{-1}$. For a reaction $R_2, \Delta G = yKJmol^{-1}$. Reaction R_1 is non-spontaneous but along with R_2 it is spontaneous. This means that

A. x is -ve, y is +ve but in magnitude x gt y

B. x is +ve, y is -ve but in magnitude y gt x

C. Both x and y are -ve but not equal

D. Both x and y are +ve but not equal.

Answer: B

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34.

LIST - 1	LIST - 2
A) $Hp > HR$	1) Exothermic
B) $P\Delta V$	2) Total heat content
C) $E + PV$	3) $\Delta H$is positive
D) $HR > Hp$	4) Zero at constant volume

The correct match is

A. $\begin{array}{cccc} A & B & C & D \\ 3 & 4 & 2 & 1 \end{array}$

B. $\begin{array}{cccc} A & B & C & D \\ 2 & 3 & 1 & 4 \end{array}$

C. $\begin{array}{cccc} A & B & C & D \\ 1 & 3 & 4 & 2 \end{array}$

D. $\begin{array}{cccc} A & B & C & D \\ 1 & 3 & 4 & 2 \end{array}$

Answer: A

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35.

List - I (Freezing of water)	List - II
A) Water at - $10^{\circ} C$	I) $\Delta G = 0$
B) Water at $0^{\circ} C$	II) $\Delta G + Ve$
C) Water at $+10^{\circ} C$	III) ΔG - Ve

The correct match is

A. $\begin{array}{ccc} A & B & C \\ II & I & III \end{array}$

B. $\begin{array}{ccc} A & B & C \\ III & I & II \end{array}$

C. $\begin{array}{ccc} A & B & C \\ I & II & III \end{array}$

D. $\begin{array}{ccc} A & B & C \\ III & II & I \end{array}$

Answer: A

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36. (A): The entropy of the universe is continuously increasing.

(R): All naturally occurring processes are accompanied by increase in entropy.

A. Both A and R are true and R is thecorrect explanation

B. Both A and R are true but R is not the correctexplanation of A

C. A is true but R is false

D. A is false but R is true

Answer: A

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37. (A): For a process to be spontaneous, the change in free energy must be negative. (R): The change in entropy for a process must always be positive if it is spontaneous.

A. Both A and R are true and R is thecorrect explanation

B. Both A and R are true but R is not the correctexplanation of A

C. A is true but R is false

D. A is false but R is true

Answer: C

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38. (A): Entropy of a perfect crystalline substance at absolute zero is zero

(R): At absolute zero translation kinetic energy of a system is zero.

A. Both A and R are true and R is thecorrect explanation

B. Both A and R are true but R is not the correctexplanation of A

C. A is true but R is false

D. A is false but R is true

Answer: A

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39. Which one ofthe following is correct for a spontaneous reaction at any temperature ?

A. $\Delta H = -ve, \Delta S = +ve, \Delta G = -ve$

B. $\Delta H = -ve, \Delta S = -ve, \Delta G = -ve$

C. $\Delta H = +ve, \Delta S = +ve, \Delta G = -ve$

D. $\Delta H = -ve, \Delta S = +ve, \Delta G = +ve$

Answer: A

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40. The correct statement regarding entropy is

A. At absolute zero temperature, entropy of a perfectly crystalline solid is zero.

B. At absolute zero temperature, the entropy of a perfectly crystalline substance is +Ve.

C. At absolute zero temperature, the entropy of all crystalline substances is zero.

D. At $0^\circ C$, the entropy of a perfect crystalline solid is zero.

Answer: A

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41. The correct thermodynamic conditions for the spontaneous reaction at all temperatures is

A. $\Delta H < 0$ and $\Delta S = 0$

B. $\Delta H > 0$ and $\Delta S < 0$

C. $\Delta H < 0$ and $\Delta S > 0$

D. $\Delta H < 0$ and $\Delta S < 0$

Answer: C

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42. The value of $\Delta_f G^{\Theta}$ for formation of Cr_2O_3 is – 540 kJ $\text{mol}^{-1}$and that of Al_2O_3 is – 827 kJ mol^{-1} . Is the reduction of Cr_2O_3 possible with Al ?

A. Reduction of Cr_2O_3 by Al will take place

B. Oxidation of Cr_2O_3 by Al will take place

C. Neither oxidation nor reduction take place

D. Reaction is not feasible

Answer: A

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OBJECTIVE EXERCISE - 2 (FIRST LAW OF THERMODYNAMICS)

1. A system absorbs 600J of energy and does work equivalent to 400J J of energy. The internal energy changes

A. 1000J

B. 200J

C. 600J

D. 300J

Answer: B

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2. During a process work equivalent to 400J is done on a system, which gives out of 125J of energy. The change in internal energy is

A. 525J

B. 375J

C. 275J

D. 200J

Answer: C

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3. One litre-atmosphere is appromixmately equal to

A. 19.2 KJ

B. 101 J

C. 8.31 J

D. 831 J

Answer: B

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4. One mole of an ideal gas at 300K is expanded isothermally reversibly from an initial volume of 1 litre to 10 litres. The ΔE for this process is (R = 2 cal $mol^{-1}K^{-1}$)

A. 163.7 cal

B. Zero

C. 1381.1 cal

D. 9 lit atm

Answer: B

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5. An ideal gas occuping a volume of $2dm^3$ and a pressure of 5 bar undergoes isothermal and irreversible expansion against external pressure of 1 bar. The final volume of the system and work involved in the process is

A. $10dm^3, 1000J$

B. $8dm^3, -800J$

C. $10dm^3, -800J$

D. $10m^3, -1000J$

Answer: C

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6. A system absorbs 10kJ of heat at constant volume and its temperature rises from 27^0C to 37^0C. The DE of reaction is

A. 100 KJ

B. 10KJ

C. 0

D. 1 KJ

Answer: B

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7. An ideal gas expands in volume from $10^{-3}m^3$ to $10^{-2}m^3$ at 300 K against a constant pressure of 10^5Nm^{-2}. The work done is

A. $-900J$

B. $900KJ$

C. $270KJ$

D. $-900KJ$

Answer: A

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8. Two moles of an ideal gas is expanded spontaneously into a vacuum. The work done is

A. Zero

B. 2 J

C. 4J

D. 8J

Answer: A

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9. The work done when 65.38g of zinc dissolved completely in HCl in an open beaker at 300k

A. $-2494J$

B. $-249.4J$

C. $1J$

D. $-24.94J$

Answer: A

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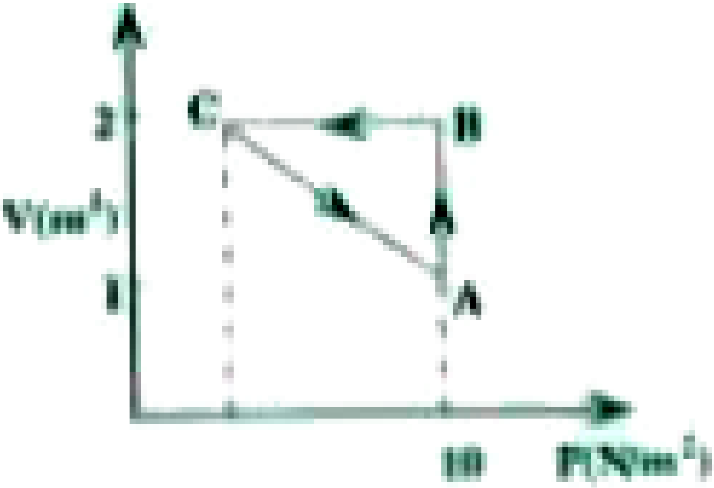
10. An ideal gas is taken through the cycle $A \rightarrow B \rightarrow C \rightarrow A$, as shown in the figure. If the net heat supplied to the gas in the cycle is 5 J, what is the work done by the gas in the process $C \rightarrow A$



A. $-5J$

B. $-10J$

C. $-15J$

D. $-20J$

Answer: A

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OBJECTIVE EXERCISE - 2 (E,H , HEAT CAPACITIES)

1. A gas absorbs 100 J of heat and is simultaneously compressed by a constant external pressure of 1.5 atm from a volume of 8.0L to 2.0L. The change in internal energy for the gas in Joules is (1L - atm = 101.32 J))

A. -1011.9

B. -909.9

C. $+909.9$

D. 1011.9

Answer: D

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2. The molar heat capacity of water at constant pressure, C, is $75JK^{-1}mol^{-1}$. When 1.0KJ of heat is supplied to 100g of water which is free to expand, the increase in temperature of water is :

A. 1.2K

B. 2.4K

C. 4.8K

D. 6.6K

Answer: B

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3. For an ideal gas, $\left(\frac{\partial E}{\partial V}\right)_T$ is

A. zero

B. $+Ve$

C. $-Ve$

D. ΔH

Answer: A

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4. For a gas having molar mass M, specific heat at constant pressure can be given as:

A. $\frac{\gamma R}{M(\gamma - 1)}$

B. $\frac{\gamma}{RM}$

C. $\frac{M}{R(\gamma - 1)}$

D. $\frac{\gamma RM}{\gamma + 1}$

Answer: A

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5. Molar heat capacity of water in equilibrium with ice at constant pressure is:

A. Zero

B. Infinity

C. $40.45KJK^{-1}mol^{-1}$

D. $5.48JK^{-1}mol^{-1}$

Answer: B

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6. Change in enthalpy when $11.2dm^3$ of He at NTP is heated in a cylinder to $100^\circ C$ is

A. 623.5J

B. 1039J

C. 1227J

D. 520J

Answer: B

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7. Latent heat of vapourisation of a liquid at 500k and 1atm pressure is 10K. Cal/mole. What is the change in internal energy when 3 moles of the liquid is vapourised at the same temperature

A. 27K.Cal

B. 7K.Cal

C. 33K. Cal

D. 25K.Cal

Answer: A

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OBJECTIVE EXERCISE - 2 (HEAT OF FORMATION AND COMBUSTION)

1. Given that $\frac{1}{2}S_{8(s)} + 6O_{2(g)} \rightarrow 4SO_{3(g)}, \Delta H^0 = -1590kJ$. The standard enthalpy of formation of SO_3 is

A. $-1590KJmol^{-1}$

B. $-397.5KJmol^{-1}$

C. $-3.975KJmol^{-1}$

D. $+397.5KJmol^{-1}$

Answer: B

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2. The amount of heat evolved on combustion of 10 grams of benzoic acid is 10 K.Cals. The heat of combustion of benzoic acid is

A. $-122K.\ Cals$

B. $-112K.\ Cals$

C. $-132K.\ Cals$

D. $-92K.\ Cals$

Answer: A

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3. Heat of combustion of C_2H_4 is -337 kCal. If 5.6 lit O_2 is used at STP, in the combustion heat liberated is ____ kCal

A. 28.08

B. 14.04

C. 42.06

D. 56.16

Answer: A

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4. Human body requires 2370 K. Cal of energy daily. The heat of combustion of glucose is -790 K.cal/mole. The amount of glucose required for daily consumption is

A. 650g

B. 540g

C. 327g

D. 490.5g

Answer: B

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5. The heats of combustion of ethane, ethene and acetylene are -341.1 kcal, -330 kcal and -310.9 kCal mol^{-1} respectively. The best fuel among them is

A. Ethane

B. Ethene

C. Acetylene

D. All are equal

Answer: C

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6. The heat of combustion of benzene at $27^{\circ} C$ found by bomb calorimeter i.e., for the reaction $C_6H_6 \_ ((l)) + 7\frac{1}{2}O_{2(g)} + 6CO_{2(g)} + 3H_2O_{(l)}$ is $-780K. Calmol^{-1}$. The heat evolved on burning 39g of benzene in an open vessel will be

A. 390 K.Cal

B. 780.9 K.Cal

C. 390.45 K.Cal

D. 780 K.Cal

Answer: C

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7. $N_2 + 3H_2 \rightarrow 2NH_3, \Delta H = -46K$. Cals. From the above reaction, heat of formation of ammonia is

A. 46 K.Cals

B. -46 K.Cals

C. -23 K.Cals

D. 23 K.Cals

Answer: C

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8. If the bond energies of H-H, Br-Br and HBr are $433, 192 \text{ and } 364 kJmol^{-1}$ respectively, then ΔH° for the reaction :

$H_{2(g)} + Br_{2(g)} \rightarrow 2HBr_{(g)}$ is

A. $-261kJ$

B. $+103kJ$

C. $+261kJ$

D. $-103kJ$

Answer: D

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9. Give that $C_s + O_{2_g} \rightarrow CO_{2_{(g)}}, \Delta H^0 = -xkJ$

$2CO_{(g)} + O_{2_{(g)}} \rightarrow 2CO_{2_{(g)}}, \Delta H^0 = -ykJ.$

A. $\dfrac{y-2x}{3}$

B. $\dfrac{y-2x}{2}$

C. $\dfrac{2x-y}{2}$

D. $\dfrac{x-y}{2}$

Answer: B

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10. Given $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g), \Delta_r H^\theta = -92.4 kJmol^{-1}$ What is the standard enthalpy of formation of NH_3 gas ?

A. -92

B. $+46$

C. $+92$

D. -46

Answer: D

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OBJECTIVE EXERCISE - 2 (HEAT OF NEUTRILIZATION)

1. Heat of neutralisation for the reaction $NaOH + HCl \rightarrow NaCl + H_2O$ is $-57.1 kJ\text{mole}^{-1}$. The heat relased when 0.25 moles of NaOH is treated with 0.25 moles of HCl is

A. 22.5 K.J/mole

B. 57.1 K.J/mole

C. 14.3 K.J/mole

D. 28.6 K.J/mole

Answer: C

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2. Given that the data for neutralization of a weak acid (HA) and strong acid with a strong base is:

$HA + OH^- \Rightarrow A^- + H_2O : \Delta H = -41.80 kJ, H^+ + OH^- \Rightarrow H_2O, \Delta H = -55.90 kJ$

The enthalpy of dissociation of weak acid would be

A. $-97.20KJ$

B. $+97.70KJ$

C. $-14.10KJ$

D. $14.10KJ$

Answer: D

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3. The heats of neutralisation of HCl with NH_4OH and that of NaOH with CH_3COOH are repectively -51.4 and $-50.6KJeq^{-1}$. The heat of neutralisation of acetic acid with NH_4OH will be

A. $-44.6KJeq^{-1}$

B. $-50.6KJeq^{-1}$

C. $-51.4KJeq^{-1}$

D. $-57.4KJeq^{-1}$

Answer: A

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4. Heat liberated in the neutralisation of 500 ml of 1N HCl and 500ml of 1N NH_4OH is -1.36 K.Cals. The heat of ionisation of NH_4OH is

A. 10.98 K.Cals

B. -12.34 K.Cals

C. -10.98 K.Cals

D. 12.34 K.Cals

Answer: A

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5. In which of the following combinatins of HCL and NaOH, the heat energy liberated is maximum

A. 10ml of 0.1M HCl+40 ml of 0.1 M NaOH

B. 30ml of 0.1M HCl+20 ml of 0.1 M NaOH

C. 25ml of 0.1 M HCl+25 ml of 0.1 M NaOH

D. 35ml of 0.1M HCl+15 ml of 0.1 M NaOH

Answer: C

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6. Under the same conditions how many mL of 1M KOH and 0.5M H_2SO_4 solutions, respctively when mixed for a total volume of 100mL produce the highest rise in temperature

A. $67:33$

B. $33:67$

C. $40:60$

D. $50:50$

Answer: D

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7. Statement -I: Heat of neutralization of HCl and NaOH is same as that of

H_2SO_4 with NaOH.

Statement-II : HCl, H_2SO_4 and NaOH are all strong electrolyte.

A. $57.32KJ$

B. $> 57.32KJ$

C. $< 57.32KJ$

D. None of these

Answer: B

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8. When 1 litre of IM HCl is mixed with 1 litre of 1M NaOH, the rise in temperature was found to be T_1. In another experiment 1 litre of 0.5 M NaOH is mixed with 1 lit. of 0.5 M HCl. The rise in temperature was found to be T_2. Then

A. $T_1 = T_2$

B. $T_1 < T_2$

C. $T_1 = 2T_2$

D. `T_2 = 2T_1

Answer: C

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9. $H_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}, \Delta H$ for the above reaction is

A. $-13.7K. Cal$

B. $+57.3KJ$

C. $-27.4K.\,Cal$

D. $-137KJ$

Answer: C

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10. For the reaction $2H_2O_{(l)} \rightarrow H_3O^{+}_{(aq)} + OH^{-}_{(aq)}$, the value of ΔH is

A. $114.6KJ$

B. $-114.6KJ$

C. $57.3KJ$

D. $-57.3KJ$

Answer: C

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11. Equal volumes of equi molar HCl and H_2SO_4 are separately neutralised by dilute NaOH solution, then heats liberated and x kCal and y kCal respectively. Which of the following is true.

A. $x = y$

B. $x = y/2$

C. $x = 2y$

D. $x = y/3$

Answer: B

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12. When $50cm^3$ of 0.2N H_2SO_4 is mixed with $50cm^3$ of 1N KOH, the heat liberated is

A. 11.45 KJ

B. 57.3 KJ

C. 573 KJ

D. 573 J

Answer: D

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OBJECTIVE EXERCISE - 2 (ΔH, ΔE AND OTHER HEATS)

1. Work done during the combustion of one mole of CH_4 in bomb calorimeter is

A. zero

B. $-101 J$

C. $-24.2 J$

D. $-1 J$

Answer: A

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2. A sample of CH_4 of 0.08g was subjected to combustion at $27^\circ C$ in a bomb calorimeter. The temperature of the calorimeter system was found to be raised by $0.25^\circ C$. If heat capacity of calorimeter is $18kJ/^\circ C, \Delta H$ for combustion of CH_4 at $27^\circ C$ is

A. -$900KJ/\text{mole}$

B. -$905KJ/\text{mole}$

C. -$895KJ/\text{mole}$

D. -$890KJ/\text{mole}$

Answer: B

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3. For the reaction of one mole zinc dust with one mole sulphuric acid in a bomb calorimeter, ΔU and w correspond to

A. $\Delta U < 0, w = 0$

B. $\Delta U = 0$, w = 0`

C. $\Delta U > 0, w = 0$

D. $\Delta U > 0, w > 0$

Answer: A

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4. 100ml of water at $20^\circ C$ and 100ml of water at $40^\circ C$ are mixed in calorimeter until constant temperature reached. Now temperature of the mixture is $28^\circ C$. Water equivalent of calorimeter is

A. 50J

B. 104.5J

C. $-24.2J$

D. 209J

Answer: D

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5. Heat of combustion of benzoic acid $\left(C_6H_5COOH\right)$ at constant volume at $25^\circ C$ is $-3233KJ/\text{mole}$. When 0.5g of benzoic acid is burnt in bomb calorimeter, the temperature of calorimeter increased by $0.53^\circ C$. Now in the same bomb calorimeter 1g of C_2H_6 burnt then temperature increased by $2.04^\circ C$. ΔH for combustion of $C_2H_6$is

A. $-1530KJ/\text{mole}$

B. $-1536.2KJ/\text{mole}$

C. $-1522.8KJ/\text{mole}$

D. $+1536.2KJ/\text{mole}.$

Answer: B

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6. The dissociation energy of CH_4 is $400K.\ Calmol^{-1}$ and that of ethane is $670K.\ Calmol^{-1}$. The C-C bond energy is:

A. 270K.Cal

B. 70K. Cal

C. 200K.Cal

D. 240K. Cal

Answer: B

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7. The heat of atomisation of $PH_{3(g)}$ is 228 kCal mol^{-1} and that of $P_2H_{2(g)}$ is 355 kCal mol^{-1}. The energy of the P-P bond is (kn kCal)

A. 102

B. 51

C. 26

D. 204

Answer: B

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8. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}, \Delta H = -286.2KJ$

$H_2O_{(l)} \rightarrow H^+_{(aq)} + OH^-_{(aq)}, \Delta H = +57.3KJ$

Enthalpy of ionization OH^- in aqueons solution is

A. $-228.5KJ$

B. $+228.5KJ$

C. $-343.5KJ$

D. zero

Answer: A

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9. Among the following ions, for which one standard enthalpy of ionisation is zero

A. $OH^{-}_{(aq)}$

B. $CI^{-}_{(aq)}$

C. $H^{-}_{(aq)}$

D. $H^{+}_{(aq)}$

Answer: D

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10. $\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \to HCl_{(g)}, \Delta H^0 = -92.4$ kJ/mole, $HCl_{(g)} + nH_2O \to H^{+}_{(aq)} + Cl^{-}_{(aq)}, \Delta H^0 = -74.8$ kJ/mole $\Delta H^0 f$ for $Cl^{-}_{(aq)}$ is

A. $-17.6KJ/\text{mole}$

B. $-167.2KJ/\text{mole}$

C. $+17.6KJ/\text{mole}$

D. $-35.2KJ/\text{mole}$

Answer: B

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11. If the standard molar enthalpy of formation of $CaO_{(s)}, CO_{2(s)}$ and $CaCO_{3(s)}$ is $-635, -393$ and $-1207k\text{Jmol}^{-1}$ respectively, the $\Delta_r H^{\odot}$ in $kJmol^{-1}$ for the reaction $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ is

A. -179

B. 965

C. 2235

D. $+179$

Answer: D

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12. Calculate ΔH in Joules for

$C_{(\text{graphite})} \rightarrow C_{(\text{Diamond})}$

by using the following data

$C_{(\text{graphiter})} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H^{\circ} = -393.5KJ$

$C_{(\text{Diamond})} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H^{\circ} = -395.4KJ$

A. 1900

B. -788.9×10^3

C. 190000

D. 788×10^3

Answer: A

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13. Given ΔH_r° for $CO_2(g), CO_g$ and $H_2O(g)$ are -393.5, -110.5 and -241.8 $KJmol^{-1}$ respectively. The $\Delta H_r^\circ \left(\in KJmol^{-1} \right]$ for the reaction $CO_2(g) + H_2(g) \rightarrow CO_g + H_2O(g)$ is

A. 524.1

B. -262.5

C. 41.7

D. 41.2

Answer: D

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OBJECTIVE EXERCISE - 2 (HESS LAW)

1. The standard enthalpies of formation of $H_2O_{2(l)}$ and $H_2O_{(l)}$ are $-187.8kJ\text{mole}^{-1}$ and $-285.8kJ\text{mole}^{-1}$ respectively. The ΔH^0 for the decomposition of one mole of $H_2O_{2(l)}$ to$H_2O_{(l)}$ and $O_{2(g)}$ is

A. $-473.6K.J.\text{mole}^{-1}$

B. $-98.0K.J.\text{mole}^{-1}$

C. $+473.6K.J.\text{mole}^{-1}$

D. $+187.8K.J.\text{mole}^{-1}$

Answer: B

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2. $N_{2(g)} + 2O_{2(g)} \rightarrow 2NO_2 + xkJ, 2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)} + ykJ$. The enthalpy of formation of NO is

A. (2X – 2Y)

B. X - Y

C. 1/2 (Y-X)

D. 1/2 (X - Y)

Answer: C

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3. If $S + O_2 \rightarrow SO_2, \Delta H = -398.2kJ$

$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3, \Delta H = -98.7kJ, SO_3 + H_2O \rightarrow H_2SO_4, \Delta H = -130.2kJ$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O, \Delta H = -227.3kJ$

The enthalpy of formation of sulphuric acid at 298K will be

A. $-854.4K.J$

B. $-754.4KJ$

C. $-650.3KJ$

D. $433.7KJ$

Answer: A

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4. Given that

$S_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow SO_{3(g)} + 2xK.\,cal$

$SO_{2(g)} + ½O_{2(g)} \rightarrow SO_{3(g)} + yK.\,Cal.$

Which would be the enthalpy of formation SO_2 ?

A. $(2x - y)$

B. $(2x + y)$

C. $(y - 2x)$

D. $\frac{2x}{y}$

Answer: C

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5. Given

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -395kJ, S_{(g)} + O_{2(g)} \rightarrow SO_{2(g)}, \Delta H = -295$

$CS_{2(l)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{2(g)}, \Delta H = -1110kJ$

The heat of formation of $CS_{2(l)}$ is

A. $+125KJmol^{-1}$

B. $31.25KJmol^{-1}$

C. $62.5KJmol^{-1}$

D. $250KJmol^{-1}$

Answer: A

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6. 1)$C_{\text{Graphite}} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -94K.Cals$

2) $C_{\text{Diamond}} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -94.5K.Cals$

From the above data the heat of transition of $C_{\text{diamond}} \rightarrow C_{\text{Graphite}}$

A. $-50Cal$

B. $-100Cal$

C. $-500Cal$

D. $100Cal$

Answer: C

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7. ΔH of combustion of yellow P and red P are `- 11 K.J and -9.78 KJ respectively DeltaH of transition of yellow P to Red P is

A. $-20.78KJ$

B. $-1.22K.J$

C. $+1, 22KJ$

D. $+20.78KJ$

Answer: B

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8. How much energy is released when 6 mole of octane is burnt in air? GivenΔH_f^0 for $CO_{2(g)}, H_2O_{(g)}$ and $C_8H_{18(l)}$ respectively are

$-390, \ -240$ and $+160$ KJ/mol

A. $-32.6MJ$

B. $-37.4MJ$

C. $-35.5MJ$

D. $-20.0MJ$

Answer: A

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9. Given

$C + 2S \rightarrow CS_2, \Delta Hf^0 = +117.0KJmol^{-1}, C + O_2 \rightarrow CO_2, \Delta Hf^0 = -393.0KJmol$

. The heat of combustion of $CS_2 + 3O_2 \rightarrow CO_2 + 2SO_2$ is

A. $-807KJmol^{-1}$

B. $-1104KJmol^{-1}$

C. $+1104KJmol^{-1}$

D. $+807KJmol^{-1}$

Answer: B

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10. The standard heat of formation of sodium ions in aqueous solution from the following data :

Heat of formation of $NaOH(aq)$ at $25^{\circ}C = -470.7KJ$:

Heat of formation of OH^{-1} at $25^{\circ}C = -228.8KJ$ is :

A. $-251.9KJ$

B. $241.9KJ$

C. $-241.9KJ$

D. $300KJmol^{-1}$

Answer: C

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11. The lattice energy of solid NaCl is 180K. Call per mol. The dissolution of the solid in water in the form of ions is endothermic to the extent of 1K, Cal per mol. If the solvation energies of Na^{+} and Cl^{-} ions are in ratio $6:5$, what is the enthalpy of hydration of sodium ion?

A. $-85.6K. Cal/mol$

B. $-97.5K. Cal/mol$

C. $82.6K. Cal/mol$

D. $+100K. Cal/mol$

Answer: B

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12. Heat of formation of CO and CO_2 are -26.4, -94.0 kcal/mole respectively. What is the heat of combustion of CO in kcals?

A. $+26.4$

B. 120.6

C. -67.6

D. 135.2

Answer: C

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13. $Cl_{(g)} + e^{-} \rightarrow Cl^{-}_{(g)}, E_A = -348 kJ/\text{mole}$ at 0 K. then ΔH for same process at 300K (in kJ) [R=8J/mol/K] [Hint : $\Delta H = EA - \frac{5}{2}RT$].

A. $+354$

B. $+348$

C. -354

D. Zero

Answer: C

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14. For the reaction:

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}, \Delta H = -571kJ$

bond energy of (H-H) = 435 kJ, of (O = O) = 498kJ , then the average bond energy of O-H bond using the above data

A. $484kJ$

B. $-84kJ$

C. $271kJ$

D. $-271kJ$

Answer: A

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15. If values of ΔH_f° of $ICl_{(g)}, Cl_{(g)}$ and $I_{(g)}$ are respectively $17.57, 121.34, 106.96 Jmol^{-1}$. The value of $I - Cl$ (bond energy) in $Jmol^{-1}$ is:

A. 17.57

B. 10.73

C. 35.15

D. 106.96

Answer: B

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16. The enthalpy changes for the following processes are listed below:

$Cl_{2(g)} \rightarrow 2Cl_{(g)}, \Delta H = 242.3kJmol^{-1}$

$I_{2(g)} \rightarrow r2I_{(g)}, \Delta H = 151.0kJmol^{-1}$

$ICl_{(g)} \rightarrow I_{(g)} + Cl_{(g)}, \Delta H = 211.3kJmol^{-1}$

$I_{2(s)} \rightarrow I_{2(g)}, \Delta H = 62.76kJmol^{-1}$

Given that the standard states for iodine and chlorine are $I_{2(s)}$ and $Cl_{2(g)}$, the standard enthalpy of formation for ICT is:

A. $-14.6kJmol^{-1}$

B. $-16.8kJmol^{-1}$

C. $+16.8kJmol^{-1}$

D. $+244.8kJmol^{-1}$

Answer: C

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17. The enthalpies of HCl, NaOH ,NaCl and H_2O are $-120, -82, -148$ and -68 kCals. Respectively. ΔH of the following reaction is $HCl + NaOH \rightarrow NaCl + H_2O$

A. $-28.7K. Cals$

B. $-18K. Cals$

C. $-57.3K. Cals$

D. $-14K. Cals$

Answer: D

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18. ΔH^0 for a reaction $F_2 + 2HCl \rightarrow 2HF + Cl_2$ is given as $-352.8kJ$. ΔH_f^0 for HF is $-268.3KJmol^{-1}$, then ΔH_f^0 of HCl would be

A. $-22kJmol^{-1}$

B. $880kJmol^{-1}$

C. $-91.9kJmol^{-1}$

D. $-183.8kJmol^{-1}$

Answer: C

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19. What is theheat of formation of C_6H_6, given that the heats of combustion of benzene, carbon and hydrogen are 782, 94 and 68K. Cal respectively

A. $+14K.\ Cal$

B. $-14K.\ Cal$

C. $+28K.\ Cal$

D. $-28K.\ Cal$

Answer: A

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20. The heats of combustion of carbon hydrogen and acetylene are $-394kJ$, $-286kJ$ and $-1301kJ$ respectively. Calculate heat of formation of C_2H_2

A. $621KJ$

B. $454KJ$

C. $-227K.\ J$

D. $227KJ$

Answer: D

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21. The enthalpies of combustion of carbon and carbon monoxide are $-390 KJmol^{-1}$ and $-278 KJmol^{-1}$ respectively. The enthalpy of formation of carbon monoxide is

A. $668 KJmol^{-1}$

B. $112 KJmol^{-1}$

C. $-112 KJmol^{-1}$

D. $-668 KJmol^{-1}$

Answer: C

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22. Calculate the heat of formation of KOH from the following data

$$K_{(s)} + H_2O + aq \to KOH_{(aq)} + \frac{1}{2}H_{2(g)}, \Delta H = -48.4K.\,Cal$$

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \to H_2O_{(l)}, \Delta H = -68.44K.\,Cal$$

$$KOH_{(s)} + aq \to KOH_{aq}, \Delta H = -14.01K.\,Cal$$

A. $+102.83$

B. $+130.85$

C. -102.83

D. -130.85

Answer: C

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OBJECTIVE EXERCISE - 2 (ENTROPY AND GIBBS ENERGY)

1. ΔS_{surr} for $H_2 + 1/2O_2 \to H_2O, \Delta H - 280kJ$ at 400K is

A. 700 J/g/K

B. 700 KJ / mol / K

C. 700 J/mol/K

D. 0.7 J/mol / K

Answer: C

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2. $\Delta S_{\text{says}}\text{for}4Fe_{(s)} + 3O_2 \rightarrow 2Fe_2O_{3(s)}$ is - $550J/k/mol$ at 298K. If enthalpy change for same process is - $1600kJ/mol$, DS_{total} (in J/mol/K) is

A. $\left[\frac{1600}{298} \times 10^3\right] + 550 > 0$

B. $\left[\frac{1600}{298} \times 10^3\right]$ - $550 > 0$

C. 550 - $\left[\frac{1600}{298}\right] < 0$

D. $\left[\frac{1600 + 550}{298}\right] > 0$

Answer: B

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3. For a certain reaction, $\Delta H^0 \ \& \ \Delta S^0$ respectively are 400kJ & 200 J/mol/K. The process is non-spontaneous at

A. 2100 K

B. 2010 K

C. 1990 K

D. 2020 K

Answer: C

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4. For which one of the following reactions , the entropy changes is positive ?

A. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$

B. $Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$

C. $NaCl(l) \rightarrow NaCl(s)$

D. $H_2O(l) \rightarrow H_2O(g)$

Answer: B

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5. The temperature of K at which ΔG =0 for a given reaction with ΔH= -20.5 kJ mol^{-1}andΔS =- 50.0 $JK^{-1}mol^{-1}$

A. -410

B. 2.44

C. 410

D. -2.44

Answer: B

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6. Enthalpy of vapourisation for water is 186.5 KJ mole^{-1}. The entropy change during vapourisation is _____ $KJ\text{mole}^{-1}$

A. 0.5

B. 1.0

C. 1.5

D. 2.0

Answer: A

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7. $S^0_{H_{2(g)}} = 130.6JK^{-1}mol^{-1}, S^0_{H_2O_{(l)}} = 69.9JK^{-1}mol^{-1}, S^0_{O_{2(g)}} = 205JK^{-1}$, Then the absolute entropy change of $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$ is

A. $-163.2Jmol^{-1}K^{-1}$

B. $+163.2Jmol^{-1}K^{-1}$

C. $-303Jmol^{-1}K^{-1}$

D. $+303Jmol^{-1}K^{-1}$

Answer: A

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8. At $0^{\circ}C$ ice and water are in equilibrium and $\Delta H = 6.0KJ$ then ΔS will be

A. $22JK^{-1}mol^{-1}$

B. $35JK^{-1}mol^{-1}$

C. $48JK^{-1}mol^{-1}$

D. $100JK^{-1}mol^{-1}$

Answer: A

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9. Melting & boiling point of NaCl respectively are 1080 K & 1600K. ΔS for stage -I & II in $NaCl_{(s)} \overset{I}{\to} \Delta H_{\text{fus}} = 30kJ NaCl_{(l)} \overset{II}{\to} \Delta H_{\text{vap}} = 160kJ$ are

A. $\begin{array}{ll} \Delta S(I) & \Delta S(II) \\ 1/36(KJ/mol/K) & 1/10(KJ/mol/K) \end{array}$

B. $\begin{array}{ll} \Delta S(I) & \Delta S(II) \\ 36(KJ/mol/K) & 100(KJ/mol/K) \end{array}$

C. $\begin{array}{ll} \Delta S(I) & \Delta S(II) \\ 1/36(KJ/mol/K) & 10(KJ/mol/K) \end{array}$

D. $\begin{array}{ll} \Delta S(I) & \Delta S(II) \\ 36(KJ/mol/K) & 1/10(KJ/mol/K) \end{array}$

Answer: A

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10. One mole of ice is converted into water at 273 K. The entropies of $H_2O_{(s)}$ and $H_2O_{(l)}$ are 38.20 and $60.01 Jmol^{-1}K^{-1}$ respectively. The enthalpy change for the conversion is

A. $59.54 Jmol^{-1}$

B. $5954 Jmol^{-1}$

C. $595.4 Jmol^{-1}$

D. $320.6 Jmol^{-1}$

Answer: B

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11. ΔS for vapousization of 900 g water (in KJ//K) is $\left[\Delta H_{vap} = 40 KJ/mol\right]$

A. (900×40)

B. $\frac{50 \times 40}{373}$

C. $\frac{900 \times 40}{373}$

D. $\frac{18 \times 40}{373}$

Answer: B

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12. Calculate ΔG° for the following cell reaction

A. $-305 kJ/\text{mol}$

B. $-301 kJ/\text{mol}$

C. $305 kJ/mol$

D. $301 kJ/mol$

Answer: B

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13. Identify the correct statements among the folowing

I) At equilibrium, change in entropy for a process, $DetlaS = 0$

II) Temperature is an extensive property

III)For a cyclic process $\Delta U \ne 0$

IV)During free expansion of a gas under reversible or irreversible condition $\Delta W = 0$

A. I & II

B. I & IV

C. II & III

D. I & III

Answer: C

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14. A reaction has both DH and DS negative. The rate of reaction

A. Increases with increase in temperature

B. Cannot be predicted for change in temperature

C. Increases with decrease in temperature

D. Remains unaffected by change in temperature

Answer: C

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15. Which of the following is true for spontaneous adsorption of H_2 gas without dissociation on solid surface

A. Process is exothermic and $\Delta S < 0$

B. Process is endothermic and $\Delta S > 0$

C. Process is exothermic and $\Delta S > 0$

D. Process is endothermic and $\Delta S < 0$

Answer: A

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PRACTICE EXERCISE

1. A system has internal energy equal to $E_1, 450J$ of heat is taken out of it and 600 J of work is done on it. The final energy of the system will be

A. $\left(E_1 + 150\right)$

B. $\left(E_1 + 1050\right)$

C. $\left(E_1 - 150\right)$

D. None of these

Answer: A

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2. A gas absorbs 400 J of heat and expands by $2 \times 10^{-3} m^3$ against a constant pressure of $1 \times 10^5 Nm^{-2}$. The change in internal energy is (1 L atm = 100 J)

A. Zero

B. 200

C. $-600J$

D. $-200J$

Answer: B

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3. A gas can expand from 100 ml to 250 ml under a constant pressure of 2 atm. The work done by the gas is

A. 30.38 Joule

B. 25 Joule

C. 5 k/Joule

D. 16 Joule

Answer: A

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4. If the internal energy of $22gCO_2$ at 273K is .U", internal energy of which of the following is "4U" at same T ?

A. $5.5CO_2$

B. $88gCO_2$

C. $1molCO_2$

D. $33.6litCO_2$

Answer: B

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5. $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$

$\Delta H = -200K.cal$, now ΔE Cal, now ΔE for the same process at 300 K (in K.Cal)

A. -199.8

B. -198.9

C. -190.8

D. -198.8

Answer: D

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6. A system is provided with 50 J of heat and the work done on the system is 10J .What is the change in internal energy of the system in joules ?

A. 60

B. 40

C. 50

D. 10

Answer: A

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7. $S_{(8)} + 8O_2 \rightarrow 8SO_2, \Delta H = -QKJ$, then ΔE

A. -8

B. $-Q$

C. $\frac{-Q}{8}$

D. $\frac{+Q}{8}$

Answer: C

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8. $H_2 + Cl_2 \rightarrow 2HCl + 44$ K.Cal. Heat of formation of HCl is

A. $+44K. Cal$

B. $-44K. Cal$

C. $+22K. Cal$

D. $-22K. Cal$

Answer: D

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9. Wg of benzoic acid is completely burnt in bomb calorimeter in excess of O_2 so that KJ heat is released at 298K. Internal energy change for combustion of 1 mole benzoic acid (MW = M) will be (in KJ)

A. $-Q$

B. $\frac{-(QW)}{M}$

C. $\frac{-(QM)}{W}$

D. $+Q$

Answer: C

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10. Heat of combustion of carbon is -96 k, cals. When some quantity of carbon is burnt in oxygen, 48 k.cals of heat is liberated. What is the volume (in lits) of O_2 at STP reacted with this carbon

A. 48

B. 22.4

C. 11.2

D. 1

Answer: C

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11. One mole of methanol, when burnt in oxygen, gives out $723 KJ mol^{-1}$ heat. If one mole of oxygen is used, what will be the amount of heat evolved ?

A. 723 KJ

B. 964 KJ

C. 482 KJ

D. 241KJ

Answer: C

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12. The heat of combustion of benzene at $27^{\circ} C$ and at constant volume is -3245 KJ. Then the heat of combustion of benzene at the same temperature and at constant pressure

A. $-3241.26 KJ$

B. $-3252.48 KJ$

C. $-3248.74 KJ$

D. $3248.74 KJ$

Answer: C

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13. Heat of neutralisation of H_2SO_4 with NaOH is - x KJ. Then the heat of ionisation of water is

A. -$x > KJ$

B. xKJ

C. $> xKJ$

D. $< xKJ$

Answer: B

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14. For the reaction at 298 K,

$2A + B \rightarrow C$

$\Delta H = 400kJmol^{-1}$ and $\Delta S = 0.2kJK^{-1}mol^{-1}$.

At what temperature will the reaction becomes spontaneous considering ΔH and ΔS to be constant over the temperature range?

A. $+27.4K.\ Cal$

B. $-27.4K.\ Cal$

C. $-13.7K.\ Cals$

D. $+13.7K.\ Cal$

Answer: C

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15. The heat of neutralisation of strong base and strong acid is - 57.0 KJ. The heat released when 0.5 mole of HNO_3 solution is added to 0.20 moles of NaOH solution is

A. 57.0 KJ

B. 11.40 KJ

C. 28.5 KJ

D. 34.9 KJ

Answer: B

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16. When IM H_2SO_3 is completely neutralised by sodium hydroxide, the heat liberated is 114.64 KJ. Enthalpy of neutralisation in KJ is?

A. $+114.64$

B. -114.64

C. -57.32

D. $+57.32$

Answer: C

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17. The amount of heat released, when 20 ml of 0.5 M NaOH is mixed with 100 mL of 0.1M HCl, is x kJ. The heat of neutralisation is

A. $-100x$

B. $-50x$

C. $+100x$

D. $+50x$

Answer: A

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18. $-100cm^3$ of 0.1 M HCl and $100cm^2$ of 0.1.M NaOH solutions are mixed in a calorimeter. If the heat liberated is "Q" K.Cal, the heat of neutralization (ΔH) (in K.Cal) of $HCl_{(aq)}$ and $NaOH_{(aq)}$ is

A. $10Q$

B. $-100Q$

C. $-50Q$

D. $-10Q$

Answer: B

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19. For the reaction

$H^{+} + OH^{-} + H_2O, \Delta H = -13.7K.$ cal

For $H_3O^{+} + OH^{-} \rightarrow 2H_2O, \Delta H$ will be

A. $Q_1 + Q_2$

B. $Q_1 - Q_2$

C. $Q_2 - Q_1$

D. $-\left(Q_1 + Q_2\right)$

Answer: C

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20. $BOH_{(aq)} + H^{+}_{(aq)} \rightarrow B^{+}_{(aq)} + H_2O, \Delta H = -48KJ$.Heat of ionisation of the weak base is

A. $9.3KJ$

B. $-9.3KJ$

C. $48KJ$

D. $-5KJ$

Answer: A

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21. The heat of ionisation of weak acid and a weak base are .x. and .y. k.cals. Then the heat of neutralisation of that weak acid and weak base is ....K.cal.

A. 13.7

B. $-13.7 + (x - y)$

C. $-13.7 + (x + y)$

D. $-13.7 - (x - y)$

Answer: C

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22. If the heats of formation of Al_2O_3 and Fe_2O_3 are -400 K.Cal and -190 K.Cal respectively, the heat of the following reaction is

$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$

A. $210K.\ Cal$

B. $590K.\ Cal$

C. $-590K.\ Cal$

D. $-210K.\ Cal$

Answer: D

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23. When 1 litre of IM HCl is mixed with 1 litre of 1M NaOH, the rise in temperature was found to be T_1. In another experiment 1 litre of 0.5 M NaOH is mixed with 1 lit. of 0.5 M HCl. The rise in temperature was found to be T_2. Then

A. $T_1 > T_2$

B. $T_1 = 2T_2$

C. $T_1 = T_2$

D. $T_2 = 2T_1$

Answer: D

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24. Standard molar enthalpy is lowest for

A. Diamond carbon

B. Graphite carbon

C. Water vapour

D. Liquid water

Answer: D

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25. Lattice dissociation energy and hydration energy of sodium chloride are respectively $788kJmol^{-1}$ and $784kJmol^{-1}$. Then enthalpy of solution of sodium chloride in water is

A. $+4kJmol^{-1}$

B. $+1572kJmol^{-1}$

C. $4kJmol^{-1}$

D. $-1572kJmol^{-1}$

Answer: A

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26. Example of endothermic product is

A. Carbon dioxide

B. Hydrogen fluoride

C. Nitric oxide

D. Sulphur dioxide

Answer: C

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27. If $(I) C + O_2 \rightarrow CO_2, Q_1$

$(II) C + 1/2O_2 \rightarrow CO, Q_2$

$(III) CO + 1/2O_2 \rightarrow CO_2, Q_3$

The heats of reaction Q_1 and Q_2 are $-12, -10$respectively. Then Q_3 is

A. -2

B. 2

C. -22

D. -16

Answer: A

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28. The enthalpy of formation of $N_2O_{(g)}$ and $NO_{(g)}$ are $82.0KJ$ and $90KJmol^{-1}$ respectively. The enthalpy of the reaction $2N_2O_{(g)}+O_{2(g)}\rightarrow 4NO_{(g)}$ is

A. $80KJ$

B. $88.0KJ$

C. $-16.0KJ$

D. $196.0K$

Answer: D

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29. The heats of formation of CO_2, H_2O and C_2H_4 are -94.05, -68.2 and 12.6 K.Cals/ mole, respectively. The heat of combustion of ethylene is

A. 337 K.Cal

B. 212.8 K.Cal

C. -372 K.Cal

D. -337 K.Cal

Answer: D

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30. Given that $C + O_2 \rightarrow CO_2, \Delta H^\circ = -xkJ$

$2CO + O_2 \rightarrow 2CO_2, \Delta H^\circ = -ykJ$

The enthalpy of formation of carbon monoxide will be

A. $\frac{2x - y}{2}$

B. $\frac{y - 2x}{2}$

C. $2x - y$

D. $y = 2x$

Answer: B

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31. The enthalpy of formation of ammonia is $-46.0KJmol^{-1}$. The enthalpy change for the reaction $2NH_3 \rightarrow N_2 + 3H_2$ is

A. $+46KJ$

B. $+92KJ$

C. $-23KJ$

D. $-92KJ$

Answer: B

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32. Which of the following bond has highest enthalpy

A. $N \equiv N$

B. $C \equiv N$

C. $C \equiv C$

D. $C \equiv O$

Answer: D

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33. $2C_{(s)} + \frac{1}{2}O_{2(gg)} \rightarrow CO_{2(g)}, \Delta H = -787KJ$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}, \Delta H = -286KJ$

$C_2H_{2(g)} + 2\frac{1}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + H_2O_{(l)}, \Delta H = -1301KJ.$

Heat of formation of acetylene in KJ is

A. -1802

B. $+1802$

C. -800

D. $+228$

Answer: D

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34. Heats of combustion of C_2H_4, H_2 and C_2H_6 are $-1409K.J$, $-285K.J$ and $-1558KJ$. Heat of hydrogenation of ethylene is

A. $-136KJ$

B. $-240KJ$

C. $136KJ$

D. $227KJ$

Answer: A

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35. The enthalpy of combustion of cyclohexane cyclohexene and H_2 are respectively $-3920, \ -3800$ and $-241KJmol^{-1}$. The heat of hydrogenation of cyclohexene in $KJmol^{-1}$ is

A. -121

B. $+121$

C. -242

D. $+242$

Answer: A

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36. Given that

$$CH_3CHO + \frac{5}{2}O_2 \rightarrow 2CO_2 + 2H_2O, \Delta H = -1168 KJ/\text{mole}$$

$$CH_3COOH + 2O_2 \rightarrow 2CO_2 + 2H_2O, \Delta H = -876 KJ/\text{mole}$$

ΔH for the reaction

$CH_3CHO + \frac{1}{2}O_2 \rightarrow CH_2COOH$ in KJ/mol is

A. -292

B. 378

C. 195

D. -2044

Answer: A

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37. The enthalpy of vapourisation of a liquid is $30 KJmol^{-1}$ and entropy of vapourisation is $75 Jmol^{-1}k^{-1}$. The boiling point of the liquid at 1atm pressure is.

A. 250 K

B. 400 K

C. 450 K

D. 600 K

Answer: B

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38. $H_{2(g)} \rightarrow 2H_{(g)}, \Delta H = 400KJ$, then ΔS_{system} at 2000 K is

A. $0.2KJ/mol/K$

B. $-0.2KJ/mol/K$

C. $200KJ/g/K$

D. $-400KJ/mol/K$

Answer: A

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39. Show that $A \cup B = A \cap B$ implies $A = B$

A. $[-2.303 \times 2 \times 300]KJ$

B. $\left[2.303 \times 2 \times 10^{-3} \times 300\right]KJ$

C. $[-2.303 \times 2 \times 300]Cal$

D. $\left[2.303 \times 2 \times 10^{-3} \times 300\right]K. Cal$

Answer: C

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40. Standard molar entropies of $Mg_{(s)}, C_{(s)}, MgO_{(s)} \& CO_{(g)}$ respectively are $S_1, S_2, S_3, \& S_4 J/K/mol.$ Then ΔS_{sys} for $MgO_{(s)} + C_{(s)} \rightarrow Mg_{(s)} + CO_{(g)}$

A. $S_1 + S_2 + S_3 + S_4$

B. $\left(S_1 + S_4\right) - \left(S_2 + S_3\right)$

C. $\left(S_2 + S_3\right) - \left(S_1 + S_4\right)$

D. $\left(S_4 - S_3\right)$

Answer: B

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41. ΔH and ΔS for certain reaction are $-10KJ$ and $-44\frac{J}{K}$, ΔG° is

A. $+3112J$, non -spontaneous

B. $-3112J$, spontaneous

C. $+31.12J$, non - spontaneous

D. - $31.12J$, spontaneous

Answer: A

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42. S° of N_2, H_2 and NH_3 respectively are $190, 130$ & 111 J/K/mol, then ΔS_{sys} for formation of $8.5 g NH_3$ is [in J/K]

A. - 179

B. -358

C. $+179$

D. - 89.5

Answer: D

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43. Kp for the reaction $\frac{3}{2}O_{2(g)} \overset{\rightarrow}{\leftarrow} O_{3(g)}$ at $25\,^{\circ}C$ is 2.47×10^{-29}. Then ΔG° for the conversion is

A. $163 kJmol^{-1}$

B. $264 kJmol^{-1}$

C. $376 kJmol^{-1}$

D. $488 kJmol^{-1}$

Answer: A

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44. $Zn_{(s)} + Cu^{+2}_{(aq)} \rightarrow Cu_{(s)} + Zn^{+2}_{(aq)}$,

$\Delta G = -XKJ$, $Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow 2Ag_{(s)} + Cu^{+2}_{(aq)}$,

$\Delta G = -YKJ$, then

ΔG for $Zn_{(s)} + 2Ag^{+}_{(aq)} \rightarrow 2Ag_{(s)} + Zn^{+2}_{(aq)}$ will be (in KJ)

A. $-(X + Y)$

B. $(Y - X)$

C. $2(X - Y)$

D. $(X - Y)$

Answer: B

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45. For a process change in enthalpy is 36 kJ.mol and change in entropy is 120 J $\text{mole}^{-1}K^{-1}$. The temperature at which the sywstem attains eequibrium is

A. $50^\circ C$

B. $47^\circ C$

C. $27^\circ C$

D. $12^\circ C$

Answer: C

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46. For which of the following cases $\Delta S = \frac{\Delta H}{T}$

A. A process for which $\Delta C_p = 0$ but $\Delta C_v = 0$

B. An adiabatic process

C. An isobaric or isothermal process

D. An isothermal reversible transition process

Answer: D

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47. Calculate work done when 1 mole of an ideal gas is expanded reversibly from 20 L to 40 L at a constant temperature of 300 K.

A. $7.78KJ$

B. $-1.73KJ$

C. $11.73KJ$

D. -$4.78KJ$

Answer: B

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48. The entropy change in adiabatic process is

A. Zero

B. Always positive

C. Always negative

D. Positive or negative

Answer: A

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49. If w_1, w_2, w_3, and we are work done in isothermal adiabatic, isobaric and isochoric reversible processes, then the correct sequence (for expansion) would be

A. $w_1 > w_2 > w_3 > w_4$

B. $w_3 > w_2 > w_1 > w_4$

C. $w_3 > w_2 > w_4 > w_1$

D. $w_3 > w_1 > w_2 > w_4$

Answer: D

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50. Molar heat capacity $\left(C_p\right)$ of water of constant pressure is $75JK^{-1}mol^{-4}$. The increase in temperature (in K) of 100g of water when I kJ of heat is supplied to it is

A. 2.4

B. 0.24

C. 1.3

D. 0.13

Answer: C

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EXAMPLE

1. A closed steel Mask contains hot tea. What type of system is this?

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2. Does the temperature remain constant in an adiabatic process ?

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3. 10 grams of steam has higher internal energy than 10 grams of ice. Comment.

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4. A chamber contains $77 g of CO_2$. The chamber was divided into three compartments X, Y and Z as shown below. Suggest the relation between the internal energies of the gas in the three compartments X, Y and Z.

$X\ 11 g CO_2 \quad y 22 g CO_2 \quad Z 44 g CO_2$

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5. In a process, a system loses 125 J of heat when 400 J of work was done on the system. Calculate the change in internal energy.

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6. A system absorbs 100J of heat at constant volume and its temperature raises from 300K to 320K, Calculate the change in internal energy.

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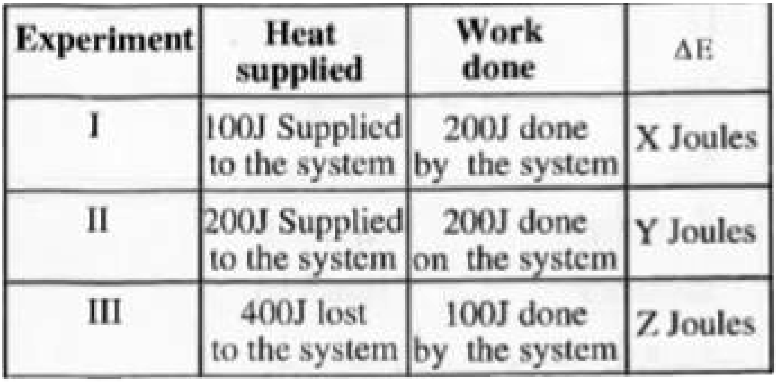
7. From the observations given below, suggest the relation between X, Y and Z



Experiment	Heat supplied	Work done	ΔE
I	100J Supplied to the system	200J done by the system	X Joules
II	200J Supplied to the system	200J done on the system	Y Joules
III	400J lost to the system	100J done by the system	Z Joules

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8. What are the values of w and ΔE, when a system absorbs 250J of heat by expanding from 1 lit to 10 lit against 0.5 atm pressure and at constant temperature.

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9. $C_{(\text{graphite})} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)}$, $\Delta H = +131.4kJ$. (Assume reaction occures at STP) How much energy is absorbed when one litre of hydrogen gas is formed at STP ?

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10. $N_{2(g)} + O_{2(g)} + 180.6kJ \rightarrow 2NO_{(g)}$, calculate (a) heat of reaction, (b) heat of formation of nitric oxide and (c) heat required to form one litre of nitric oxide at $25^\circ C$.

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11. ΔH^0 for a reaction $F_2 + 2HCl \rightarrow 2HF + Cl_2$ is given as $-352.8kJ$. ΔH_f^0 for HF is $-268.3KJmol^{-1}$, then ΔH_f^0 of HCl would be

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12. Calculate enthalpy of ionisation of OH^- ion. Given: $H_2O_{(l)} \rightarrow H^+_{(aq)} + OH^-_{(aq)}, \Delta H^\circ = -285.83KJ$

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13. Calculate the value of $(\Delta H - \Delta E)$in calories for the combustion of CH_4 at $27^\circ C$.

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14. 19.5 g of benzene on burning in the free supply of oxygen liberated 12.6 kJ of energy at constant pressure. Calculate the enthalpy of combustion of benzene. Write the thermochemical equation.

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15. 4.184g of benzoic acid was burnt in bomb calorimeter. The rise in the temperature is 10°. The heat capacity of calorimeter and its contents is $2.644 kcal K^{-1}$. Calculate the heat of combustion of benzoic acid.

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16. $H_2SO_4(aq) + 2NaOH_{(aq)} \rightarrow Na_2SO_4(aq) + 2H_2O_{(l)}$. Suggest the hest of this reaction.

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17. $HCN_{(aq)} + NaOH_{(aq)} \rightarrow NaCN_{(aq)} + H_2O_{(l)}, \Delta H = -12.13 KJ.$

Calculate heat of ionisation of HCN.

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18. In the reaction between strong acid and strong base, 1.8 g of water is formed. The heat evolved is used to raise the temperature of one kg of water at $25^{\circ} C$. What is the final temperature of water?

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19. One mole of solite AB dissolved in 20 moles of water absorbed 15.9 KJ of heat. When one male of same se is dissolved in 250 moles of water $18.58 KJ$of heat is absorbed. Calculate the enthalpy of dilution

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20. The bond enthalpies of D-D and 0-0 and D - (are respectively, + 440, + 498 and $+491.5 kJmol^{-1}$. Calculate ΔH for the reaction $D_{2(g)}+\frac{1}{2}O_{2(g)} \rightarrow D_2O_{(l)}$

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21. ΔH for the formation of XY is $-200 kJmol^{-1}$.The bond enthalpies of $X_2, Y_2,$ and XY are in the ratio 1:0.5:1. Then determine the bond enthalpies.

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22. The enthalpies of combustion of carbon and carbon monoxide are $-390KJmol^{-1}$ and $-278KJmol^{-1}$ respectively. The enthalpy of formation of carbon monoxide is

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23. The heat of transition of S_α into S_β is +2.5 kJ. The heat of combustion of monoclinic sulphur is $-300kJmol^{-1}$. Calculate heat of combustion of rhombic sulphur$\left(S_\alpha\right)$.

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24. Heats of combustion of benzene, carbon and hydrogen are $-782, -94, -68kcalmol^{-1}$ respectively. Calculate heat of formation of benzene.

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25. The heat of formation of crystalline sodium chloride is $-410kJmol^{-1}$. The heat of sublimation of sodium metal is $180.8kJmol^{-1}$. The heat of dissociation of chlorine gas into atoms is $242.7kJmol^{-1}$. The ionisation energy of Na and electron affinity of Cl are $493.7kJ$ and $-368.2kJ$ respectively. Calculate the lattice energy of NaCl.

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26. The heats of formation of $CO_{2(g)}, H_2O_{(l)}$ and $CH_{4(g)}$ are respectively $-394kJmol^{-1}$, $-286kJmol^{-1}$ and $-76kJmol^{-1}$. Calculate the heat of combustion of methane.

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27. The standard molar heat for formation of ethane, carbondioxide and water are respectively, -21.1,-94.1 and -68.3 Kacal mol^{-1}. What is the standard molar heat of combustion of ethane ?

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28. Latent heat of fusion of ice is $6kJmol^{-1}$. Calculate the entropy change in the fusion of ice.

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29. The entropy change for vaporisation of a liquid is $109.3JK^{-1}mol^{-1}$. The molar heat of vaporisation of that liquid is $40.77kJmol^{-1}$. Calculate the boiling point of that liquid.

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30. Based on entropy Change predict a spontaneous reaction among the following.

$(A): \left(NH_4\right)_2CO_3(s) \rightarrow 2NH_3(g) + CO_2(g) + H_2O(l)$ and $(B): NH_3(g) + H_2S(g)$

.

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31. Calculate $DetlaG^{\circ}$ for the following reaction, $Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}. \Delta G^{\circ}_{f}$ of $Zn^{2+}_{(aq)}$ and $Cu^{+2}_{(aq)}$ is-147.2 kJ mol^(-1) and 65kJmol^(-1)` .

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32. The equilibrium constant of a reaction is 73. Calculate standard free energy change.

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33. The reaction, $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$, is spontaneous. The $\Delta S^\circ = -163.1 Jmol^{-1}K^{-1}$. The absolute entropies of $H_{2(g)}$ and $O_{2(g)}$ are $130.6 JK^{-1}mol^{-1}$ and $205 JK^{-1}mol^{-1}$ respectively. Calculate the absolute entropy of water.

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34. The standard free energy of $Cu^{+}_{(aq)}$ is $50 kJmol^{-1}$ and that of $Cu^{2+}_{(aq)}$ is $66 kJ.mol^{-1}$. Calculate the change in free energy for the reaction, $Cu^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + e^{-}$.

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35. $Zn_{(s)} + Fe^{2+}_{aq} \Leftrightarrow Zn^{2+}_{aq} + Fe_{(s)}$. The vale of $K_c$for this reaction is `10^(23). Calculate the standard free energy change.

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36. 1 g of graphite is burnt in a bomb calorimeter in excess of O_2 at 298 K and 1 atm. Pressure according to the equations.

$C_{\text{graphite}} + O_{2(g)} \rightarrow CO_{2(g)}$

During the reaction the temperature rises from 298 K to 200K. Heat capacity of the bomb calorimeter is $20.7KJK^{-1}$. What is the enthalpy change for the above reaction at 298 K 1 atm?

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37. Calculate ΔG° for conversion of oxygen to ozone, $\frac{3}{2}O_{2(g)} \rightarrow O_{3(g)}$ at 298K, if K_P for this conversion is 2.47×10^{-29}

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38. What are the sign of the entropy change (+ or -) in the following:

I : A liquid crystallises into a solid

II: Temperature of a crystalline solid is raised from 0K to 115K

III: $2NaHCO_{3(g)} \rightarrow Na_2CO_{3(g)} + CO_{2(g)} + H_2O_{(g)}$

IV : $H_{2(g)} \rightarrow 2H_{(g)}$

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39. A swimmer coming out from a pool is covered with a film of water weighing about 18g. How much heat must be supplied to evaporate this water at 298 K? Calculate the internal energy of vaporisation at $100^\circ C$.

ΔH°_{vap} for water at $373K = 40.66kJmol^{-1}$

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40. Find out the value of equilibrium constant for the following reaction at 298 K.

`2NH_(3(g)) + CO_(2(g)) standard Gibbs energy change, ΔG° at the given temperature is $-13.6kJmol^{-1}$.

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SUBJECTIVE EXERCISE-1 (LONG NSWER QUESTIONS)

1. What are the types of systems? Explain give one example each?

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2. State and explain the first law of themodynamics.

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SUBJECTIVE EXERCISE-1 (SHORT ANSWER QUESTIONS)

1. What are intensive and extensive properties?

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2. Discuss on internal energy and enthalpy?

Watch Video Solution

3. Define heat capacity and molar heat capacity. How are C_p and C_v related?

Watch Video Solution

4. What is a thermochemical equation ? Write its significance.

Watch Video Solution

5. What does one mean by exothermic and endothermic reactions? Give examples.

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6. An ideal gas expands from $500 cm^3$ to $700 cm^3$ against 1 atm pressure, by absorbing 2J of energy. Calculate change in internal energy of the ideal gas.

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7. How are ΔH and ΔE are related for a gaseous equilibrium reaction ? What is (ΔH - ΔE) for $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$?

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8. Give the mathematical formulation of first law of thermodynamics.

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9. In a process 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in internal energy for the process?

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10. For an isolated system , $\Delta U = 0$ what will be ΔS?

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11. At 400K, 5 moles of an ideal gas expands isothermally and reversibly from $10dm^3$ to $20dm^3$. Calculate the work done by the gas.

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12. 0.14kg of nitrogen at 300K is expanded isothermally and reversibly until its volume becomes doubled. Calculate the work done by the gas.

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13. 0.096kg of oxygen is compressed iso thermally and reversibly from $10^5 N.\ M^{-2}$ to $2 \times 10^5 N.\ M^2$ at 300 K. Calculate the work done during the impression process.

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SUBJECTIVE EXERCISE-1(VERY ANSWER QUESTIONS)

1. Explain "system" and "surroundings".

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2. Name three intensive properties.

Watch Video Solution

3. Name three intensive properties.

Watch Video Solution

4. Explain enthalpy.

Watch Video Solution

5. What is heat capacity? Explain.

Watch Video Solution

6. What is a thermochemical equation ? Write its significance.

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SUBJECTIVE EXERCISE-2 (LONG ANSWER QUESTIONS)

1. What is heat of a reaction? Discuss the factors on which it is dependent.

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2. What is heat of combustion ? How is it determined using bomb calorimeter ?

Watch Video Solution

3. State and explain Hess law. Write its important applications

Watch Video Solution

4. By using Born-Haber cycle to calculate the crystal lattice energy of NaCl, discuss the heats, involved in all the changes.

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SUBJECTIVE EXERCISE-2 (SHORT ANSWER QUESTIONS)

1. Define heat of neutralisation. Write the basic equation. Why the heat liberated by the neutralisation of a weak acid is less than $57.3kJmol^{-1}$?

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2. Calculate the difference between ΔE and ΔH values for the combustion reaction of ethylene at 300K

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3. When 2.4g of carbon reacted with X g of oxygen to form CO and CO_2, $50.4kJ$of heat was released and no reactant is left over. Standard heats of formation of carbon monoxide and carbondioxide are $-110.5kJmol^{-1}$ and $-393.5kJmol^{-1}$ respectively. Calculate X.

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4. Heats of atomisation of chlorine and hydrogen are $243kJmol^{-1}$ and $435kJmol^{-1}$ respectively. Heat of formation of HCl is $-92kJmol^{-1}$. Calculate the bond energy of HCL.

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5. The bond energy of $H_{2(g)}$ is 436kJ/mole. The bond enthalpy of $N_{2(g)}$ is 941.3 kJ/mole. What is the bond enthalpy of N - H if NH_3 formation energy is -46.0 kJ/mole ?

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6. Calculate the number of kJ of heat necessary to rise the temperature of 60.0 g of aluminum from $35^\circ C \rightarrow 55^\circ C$. Molar heat capacity of aluminum is 24 J $mol^{-1}K^{-1}$.

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7. The reaction of cyanamide (s), with dioxygen was carried out in a bomb calorimeter and ΔU was found to be -742.7 kJ mol^{-1} at 298 K. Calculate the enthalpy change for the reaction at 298 K.

$$NH_2CN_{(g)} + \frac{3}{2}O_2(g) \to N_{2(g)} + CO_{2(g)} + H_2O_l$$

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8. The molar heat capacity at constant volume of a system is 12.41J. mol^{-1}. In an adiabatic expansion the temperature of one mole of that gas falls from 298K to 288K. Calculate the work done by the gas.

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9. Enthalpy of ammonia and water are $-46.19KJ.\,mol^{-1}$ and $-285.9KJ.\,mol^{-1}$. Calculate AH for the reaction, $4NH_3(g) + 3O_2(g) \to 2N_2(g) + 6H_2O(l)$.

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10. The heats of combustion of hydrogen and cyclohexene are $-241 kJmol^{-1}$ and $-3800 kJmol^{-1}$.The heat of hydrogenation of cyclohexene is $-121 kJmol^{-1}$. Calculate the heat of combustion of cyclohexane.

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11. At constant pressure, the heat of combustion of carbon monoxide at $17^0 C$ is –284.5 kJ. Calculate its heat of combustion at constant volume

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12. Heat of formation of water and heats of combustion of ethylene and acetylene are respectively $286, -1410$ and $-1299 kJmol^{-1}$, Calculate the heat of the reaction,

$C_2H_{2(g)} + H_{2(g)} \rightarrow C_2H_{4(g)}$.

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13. At 298K heats of formation of $H_2O_{(l)}, CO_{2(g)}, HCl_{(g)}$ and $CCl_{4(l)}$ are respectively -241.8, -393.7, -92.5 and $-106.7kJmol^{-1}$. Calculate ΔH for the following reaction

$CCl_{4(l)} + 2H_2O_{(g)} \rightarrow CO_{2(g)} + 4HCl_{(g)}$

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14. Define heat capacity. What are C_p and C_v? Show that $C_p - C_v = R$.

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15. Define Heat of solution. Give an example.

Watch Video Solution

16. Define heat of formation. Write suitable examples.

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17. Heats of ionisation of acetic acid and ammonium hydroxide are $xkJmol^{-1}$ and $ykJmol^{-1}$. Heat of neutralisation of HCl and NaOH is $zkJmol^{-1}$. Calculate the heat when acetic acid is neutralised with ammonium hydroxide. $\left(z - (x + y)kJmol^{-1}\right)$

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18. 500mL of IM HCl and 500mL of 1M NaOH are mixed in Dewar flask. Then rise in temperature is T_1. In another experiment $1000mL1MHCl$ and $1000mLof1MNaOH$are mixed in Dewar flask. Then rise in temperature is T_2. What is the relation between T_1 and T_2 ?

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SUBJECTIVE EXERCISE-2 (VERY SHORT ANSWER QUESTIONS)

1. Heat of neutralisation of $CH_3COOH_{(aq)}$ with $NaOH_{(aq)}$ is - 55.2kJ. What is heat of ionisation of CH_3COOH ?

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SUBJECTIVE EXERCISE-3 (SHORT ANSWER QUESTIONS)

1. Discuss the following:

(a) entropy and (b) entropy change.

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2. State the second law of thermodynamics and explain it.

Watch Video Solution

3. Explain whether a reaction occurs on its own, by considering the entropy change of the reaction.

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4. The absolute entropies of $H_{2(g)}, O_{2(g)}$ and $H_2O_{(l)}$ are respectively $130.6, 205.1$ and $69.9 JK - mol^{-1}$. Calculate the value of ΔS for the formation of one mole liquid water.

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SUBJECTIVE EXERCISE-3 (VERY SHORY ANSWER QUESTIONS)

1. Give the order of entropies of solid, liquid and gas.

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2. Give the units of entropy and entropy change.

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3. Calculate ΔS of water at its melting point.

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SUBJECTIVE EXERCISE-4 (LONG ANSWER QUESTIONS)

1. Explain Gibbs energy, enthalpy, entropy.

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SUBJECTIVE EXERCISE-4 (SHORY ANSWER QUESTIONS)

1. Define Gibbs energy. How is it related to enthalpy and entropy?

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2. What are the criteria for the spontaneity of chemical reaction?

Watch Video Solution

3. State the third law of thermodynamics.

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4. At 300K, heat of dissociation of lime stone is $+180kJmol^{-1}$. Entropies of $CaCO_3, CaO$ and Co_2 are respectively $93, 39$ and $213Jmol^{-1}K^{-1}$. Calculate ΔS_{total}

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5. $4Fe(s) + 3O_{2(g)} \rightarrow 2Fe_2O_3(g)$. The value of ΔS is $-550JK^{-1}$ and the value of DH is $-1650kJ$ at 298 K. Does the process is spontaneous or not?

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6. For the equilibrium , $2NOCl(g) \Leftrightarrow 2NO(g) + Cl_2(g)$ the value of the equilibrium constant, K_c is 3.75×10^{-6} at $1069K$. Calculate the K_p for the reaction at this temperature ?

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7. For the reaction at 298 K,

$2A + B \rightarrow C$

$\Delta H = 400kJmol^{-1}$ and $\Delta S = 0.2kJK^{-1}mol^{-1}$.

At what temperature will the reaction becomes spontaneous considering ΔH and ΔS to be constant over the temperature range?

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8. The e.m.f. of the cell reaction

$Zn_{(s)} + Cu^{+2}_{(aq)} \rightarrow Zn^{+2}_{(aq)} + Cu_{(s)}$ is 1.1 V. Calculate the free energy of the cell reaction.

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9. The equilibrium constant for a reaction is 10. What will be the value of ΔG?

$R = 8.314 JK^{-1} mol^{-1}, T = 300K.$

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10. For the reaction,

$2A(g) + B(g) \rightarrow 2D(g)$

$\Delta U^{\theta} = -10.5 kJ$ and $\Delta S^{\theta} = -44.1 JK^{-1}$

Calculate ΔG^{θ} for the reaction, and predict whether the reaction can occur spontaneously or not.

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11. Calculate the entropy change in surroundings when 1.00 mole of $H_2O_{(l)}$ is formed under standard conditions $\Delta_f H^\theta = -286 kJmol^{-1}$.

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12. At $60^\circ C$ dinitrogen tetroxide is fifty percent dissociated. Calculate the standard free energy change at this temperature and at one atmosphere.

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13. $N_2 + 3H_2 \to 2NH_3, \Delta H = -46K$. Cals. From the above reaction, heat of formation of ammonia is

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14. At $427^\circ C$, for a given change the values of ΔG and ΔH are $-11,500 Jmol^{-1}$ and $-11,300 Jmol^{-1}$ respectively. Calculate the value of ΔS

.

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15. The reaction $A + B \Leftrightarrow C$ has the value of ΔH and value of ΔS respectively -12.52kJ and $313 Jmol^{-1}K^{-1}$.At What temperature the reaction attains equilibrium state.

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SUBJECTIVE EXERCISE-4 (VERY SHORY ANSWER QUESTIONS)

1. Give Gibbs Equation.

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2. Give Debye equation.

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3. Define Nernst heat theorem.

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4. Define free energy.

Watch Video Solution

5. Suggest the spontaneity for the thermal decomposition of lime stone and discuss.

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OBJECTIVE EXERCISE-1

1. Which of the following come under the view of thermodynamics?

A. Predicting the feasibility of chemical change

B. Predicting the extent of completion of the chemical change

C. Rate at which chemical change occurs at particular set of conditions

D. Effect of temperature on the rate of reaction

Answer: A

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2. An isolated system is that in which:

A. There is no exchange of energy with the surroundings

B. There is exchange of mass and energy with the surroundings

C. There is no exchange of mass and energy with the surroundings

D. There is exchange of mass with the sounroundings

Answer: C

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3. A well stoppered thermos flask contains some ice cubes. This is an example of

A. Closed system

B. Open system

C. Isolated system

D. Non-thermodynamic system

Answer: C

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4. A system which can exchange energy with the surrounding but not matter is called

A. A heterogeneous system

B. An open system

C. A closed system

D. An isolated system

Answer: C

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5. An intensive property of theromdynamics means a property which depends

A. On the amount of the substance only

B. On the nature of the substance only

C. Both on the amount as well as nature of the substance

D. Neither on the amount nor on the nature

Answer: B

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6. The intensive property among these quantities is

A. Weight

B. Density

C. Entropy

D. Volume

Answer: B

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7. Which is an extensive property of the system?

A. Volume

B. Viscosity

C. Temperature

D. Refractive index

Answer: A

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8. In which of the following sets, all the properties belong to same category (all extensive or all intensive)

A. Mass, volume, specific heat

B. Temperature, pressure, volume

C. Heat capacity, density, entropy

D. Enthalpy, internal energy, volume

Answer: D

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9. Which of the following statements is correct?

A. Only internal energy is a state function but not work

B. Only work is a state function but not internal energy

C. Both internal energy and work are state functions

D. Neither internal energy nor work is a state function

Answer: A

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10. Which of the following statement is false ?

A. Work is a state function

B. Temperature is a state function

C. Change of state is completely defined when initial and final states are specified

D. Work appears at the boundary of the system

Answer: A

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11. A process in which no heat change takes place is called

A. An isothermal process

B. An adiabatic process

C. An isobaric process

D. An isochoric process

Answer: B

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12. A gaseous system changes from state $A(P_1, V_1, T_1)$ to $B(P_2, V_2, T_2)$, B to $C(P_3, V_3, T_3)$ and finally from C to A. The whole process may be called

A. Reversible process

B. Cyclic process

C. Isobaric process

D. Spontaneous process

Answer: B

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13. A gas expands isothermally and reversibly. The work done by the gas is

A. Zero

B. Maximum

C. Minimum

D. Not known

Answer: B

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14. For the adiabatic expansion of an ideal gas

A. Increase in temperature

B. $q = 0$

C. $W = 0$

D. $\Delta E = 0$

Answer: B

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15. Which among the following gives the expression for work done by ideal gas ?

A. - $P\Delta V$

B. - $nRT\ln\frac{V_2}{V_1}$

C. Both 1 and 2

D. Neither 1 nor 2

Answer: C

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16. What is correct about isothermal expansion of the ideal gas ?

A. $W_{rev} = W_{irr}$

B. $W_{rev} + W_{irr} = 0$

C. $W_{rev} > W_{irr}$

D. $q_{rev} = q_{irr}$

Answer: C

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17. In thermodynamics, a process is called reversible when

A. Surroundings and system change into each other

B. There is no boundary between system and surroundings

C. Surroundings are always in equilibrium with system

D. System changes into surroundings spontaneously

Answer: C

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18. In an adiabatic expansion of ideal gas:

A. $\Delta E = W$

B. ΔE is maximum

C. $\Delta E = 0$

D. dp is maximum

Answer: A

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19. A heat engine absorbs heat q_1 from a source at temperature T_1 and heat q_2 from a source at temperature T_2. Work done is found to be $J\left(q_1 + q_2\right)$. This is in accordance with

A. Violates 1st law of thermodynamics

B. Violates 1st law of thermodynamics if Q_1 is negative

C. Violates 1st law of thermodynamics if Q_2 is negative

D. Does not violate first law of thermodynamics

Answer: D

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20. Two moles of an ideal gas is expanded isothermally and reversibly from 1 litre to 10 litre at 300 K. The internal energy change (in kJ) for the process (R = 8.3J)

A. $11.4KJ$

B. $-11.4KJ$

C. $0KJ$

D. $-4.8KJ$

Answer: C

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21. During adiabatic expansion of an ideal gas, 100J work is done, ΔE of system is

A. Zero

B. 100J

C. 200J

D. - $100J$

Answer: D

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22. On which of the following factors does internal energy depend upon

A. Mass of the system

B. Temperature of the system

C. Nature of the system

D. All the above

Answer: D

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23. For a substance more internal energy is observed in [same quantity]

A. Solid state

B. Liquid state

C. Gaseous state

D. All have same

Answer: C

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24. The total heat content of a system at constant pressure is

A. Enthalpy

B. Internal energy

C. Entropy

D. Free energy

Answer: A

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25. Enthalpy "H" can be given as

A. $H = E - PV$

B. $H = E + PV$

C. $H = E + P + V$

D. $H = E - TS$

Answer: B

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26. The enthalpy is maximum for

A. 10 gms of water

B. 10 gms of ice

C. 10 gms of steam

D. Same for all

Answer: C

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27. The expression $[\Delta E / \Delta T]_V$ represent

A. Heat capacity at constant volume

B. Heat capacity at constant pressure

C. Enthalpy change

D. Eantropy change

Answer: A

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28. The heat of reaction at constant volume and temperature is represented by

A. ΔE

B. ΔH

C. ΔP

D. ΔV

Answer: A

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29. Which of the following relationships is correct for a reaction involving both reactants and products both in either solid or liquid state?

A. $\Delta H > \Delta E$

B. $\Delta H = \Delta E$

C. $\Delta H < \Delta E$

D. $\Delta H - \Delta E = \infty$

Answer: B

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30. The different between $\Delta H \text{ and } \Delta E$ for the reaction $BaCl_{2(aq)} + K_2SO_{4(aq)} \rightarrow BaSO_{4(s)} \downarrow + 2KCl_{(aq)}$

A. RT

B. 2RT

C. $(1/2)RT$

D. Zero

Answer: C

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31. For which one of the following systems $DE < DH$

A. $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

B. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

C. $2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$

D. $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$

Answer: C

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32. When a reaction is conducted in an open vessel, the heat of reaction is represented as

A. ΔH

B. ΔE

C. $P\Delta V$

D. ΔnRT

Answer: A

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33. Which of the following holds good to the laws of thermodynamics for the reaction ?

$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)}$

A. $\Delta H = \Delta E + RT$

B. $\Delta H = \Delta E - RT$

C. $\Delta H = \Delta E + 2RT$

D. $\Delta H = \Delta E - 2RT$

Answer: D

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34. For which of the following reaction $\Delta H = \Delta E + 2RT$

A. $2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

B. $NH_4HS_{(s)} \rightarrow NH_{3(g)} + H_2S_{(g)}$

C. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

D. $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

Answer: B

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35. According to IUPAC conventions, which one of the following is/are correct?

A. The heat absorbed by a system is taken as positive

B. If a system is accompained by decrease in energy, ΔE is negative

C. The work done by the system is taken as negative

D. All the above three statements are correct

Answer: D

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36. For $N_2 + 3H_2 \rightarrow 2NH_3$, enthalpy and internal energy changes respectively are, $\Delta H \ \& \ \Delta U$ then

A. $\Delta H = O$

B. $\Delta H \Delta U$

C. $\Delta H < \Delta U$

D. $\Delta H > \Delta U$

Answer: C

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37. During expansion of a gas into vaccum $\left(P_{\text{ext}} = 0\right)$, Work done is zero if the process is

(A) Reversible (B) Irreversible (C) Isothermal

A. A,B & C are true

B. A,B,&C are false

C. A & C are true

D. B & C are false

Answer: A

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38. Assertion(A): Absolute values of internal energy cannot be determined

Reason (R): It is impossible to determine the exact values of constituent energies of the substances

A. A,B and C

B. A,C and D

C. B,C and D

D. A,B and D

Answer: B

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39. Internal energy of an ideal gas depends upon

A. Pressure

B. Temperature

C. Density

D. Volume

Answer: B

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40. Give the mathematical formulation of first law of thermodynamics.

A. $C_V = aT^3$

B. $\Delta S_{\text{total}} = \Delta S_{\text{sys}} + \Delta S_{\text{sur}}$

C. $q = \Delta U + W$

D. $\Delta S_{sys} = \dfrac{qrev}{T}$

Answer: C

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41. A system absorbs 'xJ' heat and does "yJ" work. Its ΔE is +Ve when

A. $y > x$

B. $x > y$

C. $y = 2x$

D. $x = y$

Answer: B

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42. In an adiabatic expansion of ideal gas:

A. $W = -\Delta E$

B. $W = \Delta E$

C. $\Delta E = 0$

D. $W = 0$

Answer: A

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43. During isothermal expansion of an ideal gas, its internal energy

A. Decreses

B. Increases

C. May increase or decrease

D. Remains unchanged

Answer: D

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44. For the gaseous reaction involving the complete combustion of isobutane

A. $\Delta H = \Delta E$

B. $\Delta H > \Delta E$

C. $\Delta H = \Delta E = 0$

D. $\Delta H < \Delta E$

Answer: D

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45. A gas absorbs 400 J of heat and expands by $2 \times 10^{-3} m^3$ against a constant pressure of $1 \times 10^5 Nm^{-2}$. The change in internal energy is (1 L atm = 100 J)

A. Zero

B. 200 J

C. $-600J$

D. $-200J$

Answer: B

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46. A gas expands isothermally and reversibly. The work done by the gas is

A. Zero

B. Maximum

C. Minimum

D. Not known

Answer: B

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47. During adiabatic expansion of an ideal gas, 100J work is done, ΔE of system is

A. Zero

B. 100J

C. 200J

D. - $100J$

Answer: B

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48. Calculate the charge of one mole of protons.

A. 900 Cal

B. 1800 Cal

C. 7482 Cal

D. 0 Cal

Answer: A

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49. Which are of the following is an exothermic reaction?

A. $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}, \Delta H = -184.6KJ$

B. $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}, \Delta H = +180.8KJ$

C. $C_{(\text{graphite})} + H_2O_{(g)} \rightarrow CO_2 + H_{2(g)} \Delta H = -131.4KJ$

D. $C_{(\text{graphite})} + 2S_{(g)} \rightarrow CS_{2(1)}$ Delta H =+ 91.9 KJ

Answer: A

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50. Which of the following reaction do you think will result in the absorption of heat ?

A. Carbon burning in air

B. Iron reacting with sulphur to form iron sulphide

C. Formation of water gas from steam and coke

D. Formation of producer gas

Answer: C

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51. The formation of water from $H_{2(g)}$ and $O_{2(g)}$ is an exothermic reaction because

A. $H_{2(g)}$ and $O_{2(g)}$ have a higher chemical energy than water

B. $H_{2(g)}$ and $O_{2(g)}$ have a lower chemical energy than water

C. $H_{2(g)}$ and $O_{2(g)}$ have a higer temperature than water

D. Energy considerations does not arise

Answer: A

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52. When a solid melts there is

A. An increase in enthalpy

B. A decrease in enthalpy

C. No change in enthalpy

D. A decrease in internal energy

Answer: A

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53. The formation of water from $H_{2(g)}$ and $O_{2(g)}$ is an exothermic reaction because

A. $H_{2(g)}$ and $Oa_{2(g)}$ have a higher chemical energy than waer

B. $H_{2(g)}$ and $O_{2(g)}$ have a lower chemical energy than water

C. $H_{2(g)}$ and $O_{2(g)}$ have a higher temperature than water

D. Energy considerations does not arise

Answer: A

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54. Extensive property is a property whose value depends on the quantity of size of matter present in the system. Those properties which do not depend on the quantity of size of matter present are known as intensive properties. Find out the correct match

A. Internal energy → intensive property

B. Pressure → Extensive property

C. Molar heat capacity → Extensive property

D. Mass → Intensive property

Answer: C

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55. Which of the following is an endothemic reaction?

A. $N_{2(g)} + 3H_{2(g)} - 92KJ \rightarrow 2NH_{3(g)}$

B. $N_{2(g)} + O_{2(g)} + 180.8KJ \rightarrow 2NO_{(g)}$

C. $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}, \Delta H = -184.6KJ$

D. $C_{(\text{graphite})} + 2H_{2(s)} \rightarrow CH_{4(g)} + 74.8KJ$

Answer: B

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56. In exothermic reaction

A. $N_{2(g)} + O_{2(g)} + 180.8kJ \rightarrow 2NO_{(g)}$

B. $N_{2(g)} + 3H_{2(g)} - 92kJ \rightarrow 2NH_{3(g)}$

C. $C_{(\text{graphite})} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)} - 131.3KJ$

D. $C_{(\text{graphite})} + 2S_{(s)} \rightarrow CS_{2(l)} - 91.9kJ$

Answer: B

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57. For which of the following elements, the standard enthalpy is not zero?

A. C (Diamond)

B. C (Graphite)

C. Liquid mercury

D. Rhombic suphur

Answer: A

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58. The enthalpy of elements in their standard states are taken as zero. Hence the enthalpy of formation of a compound is

A. always negative

B. always positive

C. positive (or) negative

D. equal to zero

Answer: C

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59. In which of the following equations ΔH^0 reaction equal to ΔH_f^0 for the product?

A. $2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$

B. $N_{2(g)} + O_{3(g)} \rightarrow N_2O_{3(g)}$

C. $CH_{4(g)} + 2Cl_{2(g)} \rightarrow CH_2Cl_{2(l)} + 2HCl_{(g)}$

D. $Xe_{(g)} + 2F_{2(g)} \rightarrow XeF_{4(g)}$

Answer: D

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60. Identify the reaction in which the heat liberated corresponds to the heat of formation (ΔH_f):

A. $C_{(\text{diamond})} + O_{2(g)} \rightarrow CO_{2(g)} +$ heat

B. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$ + heat

C. $C_{(\text{diamond})} + 2H_{2(g)} \rightarrow CH_{4(g)}$ + heat

D. $S_{(\text{rhombic})} + O_{2(g)} \rightarrow SO_{2(g)}$ + heat

Answer: D

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61. The heat change for the following reaction $C_{(s)} + 2S_{(s)} \rightarrow CS_{2(l)}$ is known as

A. Heat of formation of CS_2

B. Heat of fusion of CS_2

C. heat of vapourisation of CS_2

D. Heat of transition of Carbon

Answer: A

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62. Which of the following reactions represents ΔH_f°

A. $C_{(\text{diamond})} + O_{2(g)} \rightarrow CO_{2(g)}$

B. $\frac{1}{2}H_{2(g)} + \frac{1}{2}F_{2(g)} \rightarrow 2NH_{3(g)}$

C. $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

D. $CO_{(g)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{2(g)}$

Answer: B

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63. Which of the following equation represents standard heat of formation of ethanol?

A. $CH_3CHO_{(l)} + \frac{1}{2}H_{2(g)} \xrightarrow{Ni} C_2H_5OH_{(l)}$

B. $2C_{\text{graphite}} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(g)}$

C. $2C_{\text{diamond}} + 3H_{2(g)} + \frac{1}{2}o_{2(g)} \rightarrow C_2H_5OH_{(g)}$

D. $2C_{\text{grapite}} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(l)}$

Answer: D

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64. The reaction which shows standard heat of formation of water correctly is

A. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O \quad , \Delta H = -68.3kcal$

B. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(s)}, \Delta H = -68.3kcal$

C. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}, \Delta H = -68.3kcal$

D. $2H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow 2H_2O_{(l)}, \Delta H = -136.6kcal$

Answer: A

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65. The enthalpy of the reaction

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}$ is ΔH_1 and that of $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)} is \Delta H_2$. Then

A. $\Delta H_1 < \Delta H_2$

B. $\Delta H_1 + \Delta H_2 = 0$

C. $\Delta H_1 > \Delta H_2$

D. $\Delta H_1 = \Delta H_2$

Answer: A

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66. In which of the following reactions heat liberated is known as standard heat of formation of CO_2?

A. $2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)} + 135.6$ kcals

B. $C_{(\text{diamond})} + O_{2(g)} \rightarrow CO_{2(g)} + 94.5$ kcals

C. $C_{(\text{grphite})} + O_{2(g)} \rightarrow CO_{2(g)}$ + 94.05 kcals

D. $CH_{4(g)} + 2O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_{2(g)} + 2H_{2(l)}$ + 2128 ikcals

Answer: C

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67. The enthalpies of formation of the elements in their standard states are

A. unity

B. Zero

C. $>$ Zero

D. < 1 but > 0

Answer: B

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68. $S_8 + 8O_2 \rightarrow 8SO_2, \Delta H = -QKJ.$ Then ΔH for $SO_2 \rightarrow S + O_2$ is

A. $-Q$

B. $+Q$

C. $\frac{+Q}{8}$

D. $\frac{-Q}{8}$

Answer: C

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69. The enthalpies of elements under the following conditions are assumed to be

A. Zero at 298 K and 1 atm

B. Unity at 298 K and 1 atm

C. Zero at 273K and 1 atm

D. Unity at 273 K and 1 atm

Answer: A

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70. Which of the following is not a combustion reaction

A. $CO+\frac{1}{2}O_2 \rightarrow CO_2$

B. $C+O_2 \rightarrow CO_2$

C. $C+\frac{1}{2}O_2 \rightarrow CO$

D. $CH_4+2O_2 \rightarrow CO_2+2H_2O$

Answer: C

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71. $C_{\text{graphite}}+O_{2(g)}:\Delta H=-393.5kJ.\ \Delta H$ of the above reaction cannot be

A. formation of CO_2

B. combustion of C

C. reaction

D. transition

Answer: D

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72. The enthalpy of combustion of a substance

A. is always positive

B. is always negative

C. can be either zero or greater than zero

D. is unpredictable till calculations are done

Answer: B

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73. The chemical process involved in the combustion reactions is

A. Oxidation

B. Reduction

C. Redox reaction

D. Disproportionation reaction

Answer: C

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74. $H_2 + Cl_2 \rightarrow 2HCl + 44$ K.Cal. Heat of formation of HCl is

A. $-44K.\ Cal$

B. $+44K.\ Cal$

C. $-22K.\ Cal$

D. $+22K.\ Cal$

Answer: D

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75. The heat of neutralisation is maximum when

A. Sodium hydroxide is neutralised by acetic acid

B. Ammonium hydroxide is neutrallised by acetic acid

C. Ammonium hydroxide is neutralised by hydrochloric acid

D. Sodium hydroxide is neutralised by hydrochloric acid.

Answer: D

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76. For the following reaction $H^{+}_{(aq)} + OH^{-}_{(aq)} \rightarrow H_2O_{(l)}, \Delta H = -Q,$ where ΔH represents

A. Heat of formation

B. Heat of combustion

C. Heat of neutralisation

D. Heat of dilution

Answer: C

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77. Enthalpy of neutralisation of all strong acids and strong bases has the same value because

A. Neutralisation leads to the formation of a salt and water

B. Strong acid and bases are ionic substances

C. Acids always furnish H^+ ions and bases always furnish OH^- ions

D. The net chemical change involves the combination of 1 mol of H^+ ions and 1 mol OH^- ions to form water.

Answer: D

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78. Equal volumes of equi molar HCl and H_2SO_4 are separately neutralised by dilute NaOH solution, then heats liberated and x kCal and y kCal respectively. Which of the following is true.

A. $x = y$

B. $x = y/2$

C. $x = y/3$

D. $x = 2y$

Answer: B

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79. The standard enthalpy of formation $\left(\Delta H^0\right)$ at 298K for methane, $CH_{4(g)}$ is 74.8 $kJmol^1$. The additional information required to determine the average energy for C-H bond formation would be

A. The dissociationeneergy of hydrogen molecule, H_2

B. The dissociation energy of hydrogen molecule, H_2

C. Latent heat of vaporisation of methane.

D. The first four ionisation energies of carbon and electron gain enthalpy of hydrogen

Answer: B

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80. For the transition $C_{(\text{diamonid})} \rightarrow C_{(\text{graphite})}, \Delta H = - 1.5KJ$. It follows that

A. Graphite is stabler than diamond

B. Diamond is stabler than graphite

C. Graphite is endothermic substance

D. Diamond is exothermic substance

Answer: A

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81. If the heats of formation of Al_2O_3 and Fe_2O_3 are -400 K.Cal and -190 K.Cal respectively, the heat of the following reaction is

$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$

A. $590K. Cal$

B. $-210K. Cal$

C. $-290K. Cal$

D. $210K. Cal$

Answer: D

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82. The expression $\Delta H_{sub}^{0} = \Delta H_{fus}^{0} + \Delta H_{vap}^{0}$ is true at all

A. temperatures

B. pressures

C. temperatures and pressures

D. temperatures and 1 atm pressure conditions

Answer: D

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83. Which of the following is not correct ?

A. Dissolution of NH_4Cl in excess of water is an endothermic process

B. Neutralisation process is always exothermic

C. The absolute value of enthalpy (H) can be determined experimentally

D. The heat of reaction at constant volume is denoted by ΔE

Answer: C

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84. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -393.5 kJ.$ This equation can not represent

A. Heat of transition

B. Heat of reaction

C. Heat of combustion

D. Heat of formation

Answer: A

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85. The enthalpy change for the process $C_{(\text{graphite})} \rightarrow C(g), \Delta H = +xKJ$ represents enthalpy of

A. Fusion

B. Sublimation

C. Combustion

D. Vapourisation

Answer: B

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86. $MgSO_{4(s)} + H_2O \rightarrow MgSO_{4(aq)}, \Delta H =$ - $84K$. Cals, ΔH of the reaction is known as

A. Heat of dilution

B. Heat of solution

C. Heat of fusion

D. Heat of transition

Answer: B

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87. Dissolution of which of the following in water is endothermic ?

A. NaOH

B. Na_2CO_3

C. $MgSO_4$

D. NH_4Cl

Answer: D

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88. Calculate ΔH in Joules for

$C_{(\text{graphite})} \rightarrow C_{(\text{Diamond})}$

by using the following data

$C_{(\text{graphiter})} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H^{\circ} = -393.5KJ$

$C_{(\text{Diamond})} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H^{\circ} = -395.4KJ$

A. 1900

B. -788.9×10^{3}

C. 190000

D. 788×10^{3}

Answer: B

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89. Hess's law states that

A. The standard enthalpy of an overall reaction is the sum of the enthalpy changes in individual reactions.

B. enthalpy of formation of compound is same as the enthalpy of decomposition of the compound into constituent elements, but with opposite sign

C. at constant temperature the pressure of a gas in inversely proportional to its volume.

D. the mass of a gas dissolved per lit of a solvent is proportional to the pressure of the gas in equilibrium with the solution.

Answer: A

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90. Hess's law states that

A. $H = E + PV$

B. It is not possible to create or destroy energy

C. Enthalpy change of a given chemical reaction is same whether the process occurs in one or more sequence of steps

D. Total entropy of the universe remains constant

Answer: C

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91. The enthalpy of combustion of cyclohexane cyclohexene and H_2 are respectively $-3920, \ -3800 \ \text{and} \ \ -241KJmol^{-1}$. The heat of hydrogenation of cyclohexene in $KJmol^{-1}$ is

A. $-205KJ$

B. $+205KJ$

C. $= 53.5KJ$

D. $+53.5KJ$

Answer: D

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92. Given that $C + O_2 \rightarrow CO_2, \Delta H^\circ = -xkJ$

$2CO + O_2 \rightarrow 2CO_2, \Delta H^\circ = -ykJ$

The enthalpy of formation of carbon monoxide will be

A. $\frac{2x - y}{2}$

B. $\frac{y - 2x}{2}$

C. $2x - y$

D. $y = 2x$

Answer: B

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93. The enthalpy change during a chemical reaction depends upon

A. path by which the reactants change into products

B. volume change accompanying the chemical reaction.

C. nature of the initial reactants and the final proucts

D. temperature of the reactants and the products

Answer: C

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94. In which of the following equations, ΔH^0 reaction equals to ΔH_f^0 for the product ?

A. $2CO_{2(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$

B. $N_{2(g)} + O_{3(g)} \rightarrow N_2O_{3(g)}$

C. $CH_{4(g)} + 2C_{2(g)} \rightarrow CH_2Cl_2(l) + 2HCl_{(g)}$

D. $Ce_{(g)} + 2F_{2(g)} \rightarrow CeF_{4(g)}$

Answer: D

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95. The reaction which shows standard heat of formation of water correctly is

A. $H_{2(g)}+\frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)},$

B. $H_{2(g)}+\frac{1}{2}O_{2(g)} \rightarrow H_2O_{(s)}, \Delta H = -68.\ 3kcal$

C. $H_{2(g)}+\frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}, \Delta H = -68.3kcal$

D. $2H_{2(g)}+O_{2(g)} \rightarrow 2H_2O_{(l)}, \Delta H = -136.6kcal$

Answer: A

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96. A hypothetical reaction $A \rightarrow 2B$, proceed through following sequence of steps

$A \rightarrow C, \Delta H = q_1, C \rightarrow D, \Delta H = q_2\frac{1}{2}D \rightarrow B, \Delta H = q_3$

The heat of reaction is

A. $q_1 + q_2 + 2q_3$

B. $q_1 + q_2 - 2q_3$

C. $q_1 + q_2 + 2q_3$

D. $q_1 + 2q_2 - 2q_3$

Answer: C

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97. The dissociation energy of CH_4 is $400K.\ Calmol^{-1}$ and that of ethane is $670K.\ Calmol^{-1}$. The C-C bond energy is:

A. 270 K.Cal

B. 70 K.Cal

C. 200 K.Cal

D. 240 K.Cal

Answer: B

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98. Heat of reaction (ΔH) is given by

A. $\Delta H =$ Activation energy of forward reaction - Activation energy of backward reaction

B. $\Delta H =$ Sum of bond energy of reactants Sum of bond energy of products

C. $\Delta H =$ Sum of enthalpy of products - Sum of enthalpy of reactants

D. All the above

Answer: D

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99. The factor which does not influence that heat of the reaction is

A. Pressure

B. Temperature

C. Physical state of substance

D. Number of steps involved in the reaction

Answer: D

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100. Hess.s law is based on

A. Law of conservation of mass

B. Gibb's equation

C. First law of thermodynamics

D. Kirchoff's equation

Answer: C

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101. Which of the following process makes the one porous?

A. Evaporation of liquid into vapour.

B. Temperature of crystalline solid increase from 0 K to 120 K.

C. Decomposition of sodium bicarbonate into sodium carbonate, water and carbondioxide

D. A liquid crystallizes into its solid.

Answer: D

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102. The incorrect statement according to second law of thermodynamics is

A. Heat cannot flow from colder body to a hotter body of its own

B. All spontaneous processes are thermodynamically irreversible

C. Heat can be converted into work completely without casusing some permanent change in the system (or) surroundings

D. Perpetul motion machine of second kind is not possible

Answer: C

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103. The enthalpy is maximum for

A. Methane

B. Water

C. Carbon

D. Phosphorus

Answer: A

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104. Incorrect statement related to an irreversible process is

A. Entropy of the universe goes on increasing

B. `Gibbs energy of the system goes on decreasing

C. Total energy of the universe goes on decreasing

D. Total energy of the universe remains constant

Answer: C

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105. Entropy of a system depends upon

A. Volume only

B. Temperature only

C. Pressure only

D. Pressure, volume and temperature

Answer: D

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106. False statement regarding second law of thermodynamics is

A. It is imposible to construct a mackine working in cycles which transforms heat from a lower temperature region to higher temperature region without intervention of any ecternal agency.

B. Heat cannot flow from a colder body to a hotter body on its own

C. Any spontaneous process taking place in isolated system, $\Delta S < O$

D. All spontaneous processes are thermodynamically irreversible and entropy of the system increases in all spontaneous processes.

Answer: C

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107. One of the following reactions involves in decrease of entropy

A. Sublimation of dry ice

B. Crystallisation of salt from brine (aq)

C. Burning of rocket fuel

D. Decomposition of gaseousN_2O_4.

Answer: B

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108. The enthalpy of the reaction $H_{2(g)} + \frac{1}{2}O_{2(g)} \to H_2O_{(g)}$ is ΔH_1 and that of $H_{2(g)} + \frac{1}{2}O_{2(g)} \to H_2O_{(l)} is \Delta H_2$. Then

A. $\Delta H = -Ve, \Delta S = +Ve$

B. $\Delta H = -Ve, \Delta S = -Ve$

C. $\Delta H = +Ve, \Delta S = -Ve$

D. $\Delta H = +Ve, \Delta S = +Ve$

Answer: B

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109. (A) : Heat flows always from a hotter body to a colder body by itself

(R): without an external aid heat cannot flow from colder body to a hotter body

A. Both A and R are correct and R is the correct explanation of A

B. Both A and R are correct and R is not the correct explanation of A

C. A is correct but R is wrong

D. A is wrong but R is correct

Answer: A

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110. Which of the following process has negative value of ΔS?

A. Dissolution of sugar in water

B. Stretching of rubber band

C. Decomposition of lime stone

D. Evaporation of water

Answer: B

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111. For the reaction $I_{2(g)} \Leftrightarrow I_{2(s)}, \Delta H = -ve$. Then choose the correct statement from the following

(A) The process is spontaneous at all temperature

(B) The process is accompained by an increase in entropy

(C) The process is accompained by a decrease in entropy

(D) The process is accompained by a decrease in enthalpy

A. Only a, b and c

B. Only b and d

C. Only c and d

D. Only a,c and d

Answer: C

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112. For a spontaneous process, in a reaction

A. $\Delta S_{\text{total}} = \left(\Delta S_{\text{system}} + \Delta S_{\text{surroundings}}\right) < O$

B. $\Delta S_{\text{total}} = \left(\Delta S_{\text{system}} + \Delta S_{\text{surroundings}}\right) = O$

C. $\Delta S_{\text{total}} = \left(\Delta S_{\text{system}} + \Delta S_{\text{surroundings}}\right) > O$

D. $\Delta S_{sys} > O$ only

Answer: C

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113. Some statements are given with regard to entropy. The incorrect statement(s) are

(A) The absolute entropy of substances cannot be determined

(B) In standard state entropy of elements is always positive

(C) The entropy of universe always decreases

(D) In a spontaneous process, for an isolated system the entropy of the system generally increases

A. A,B

B. B,C

C. A,C

D. Only C

Answer: C

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114. For an irreversible process, the value of $\left[\Delta S_{(\text{system})} + \Delta S_{(\text{surroundings})}\right]$ is

A. > 0

B. < 0

C. 0

D. $2De < sS_{(\text{surr})}$

Answer: A

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115. A process is spontaneous at all temperatures when

A. $\Delta H = -ve, \Delta S = -ve$

B. $\Delta H = +ve, \Delta S = -ve$

C. $\Delta H = -ve, \Delta S = +ve$

D. $\Delta H = +ve, \Delta S = +ve$

Answer: C

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116. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}, \Delta H = -ve$ and $\Delta G = -ve$. Then the reaction is

A. Spontaneous and endothermic

B. Spontaneous and slow

C. Non spontaneous and slow

D. Non spontaneous ans slow

Answer: C

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117. $H^{+}_{(aq)} + OH^{-}_{(aq)} \rightarrow H_2O_{(l)}, \Delta H = -ve$ and $\Delta G = -ve$ then the reaction is

A. Spontaneous and instantaneous

B. Spontaneous and endothermic

C. Spontaneous and slow

D. Non spontaneous ans slow

Answer: A

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118. Among the following what is necessary condition for spontanity of a process?

A. $\Delta S > 0$

B. $\Delta E < 0$

C. $\Delta H < 0$

D. $\Delta G < 0$

Answer: D

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119. Which of the following is the condition for a non spontaneous reaction at high temperature but spontaneous at low temperature ?

A. $\begin{array}{cc}\Delta H & \Delta S \\ - & - \end{array}$

B. $\begin{array}{cc}\Delta H & \Delta S \\ + & + \end{array}$

C. $\begin{array}{cc}\Delta H & \Delta S \\ + & - \end{array}$

D. $\begin{array}{cc}\Delta H & \Delta S \\ - & + \end{array}$

Answer: A

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120. Based on the third law of themodynamics, the entropy can be obtained using the equation.

A. $\Delta S = \frac{\Delta H}{T}$

B. $\int_0^T T.C_P^1 dT = S$

C. $\Delta G = T\Delta S$

D. $\int_0^T C_p T^{-1} dT = S$

Answer: D

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121. A chemical reaction cannot occur at all if its

A. $\Delta H is(+)ve$ and $\Delta S is(-)ve$

B. $\Delta H is(-)ve$ and $\Delta S is(+)ve$

C. ΔH and $\Delta S are(+)ve$ but $\Delta H < T\Delta S$

D. ΔH and $\Delta S\text{are}(-)ve but \Delta H > T\Delta S$

Answer: A

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122. An equilibrium reaction $X + Y \Leftrightarrow W + Z, \Delta H = +ve$ is spontaneous in the forward direction. Then corresponding sign of ΔG and ΔS should be respectively

A. $+ve, -ve$

B. $-ve, +ve$

C. $+ve, +ve$

D. $-ve, -ve$

Answer: B

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123. For the process Dry ice $\rightarrow CO_{2(g)}$

A. ΔH is positive and ΔS are negative

B. Both ΔH and ΔS are negative

C. Both ΔH and ΔS are positive

D. ΔH is negative whereas ΔS is positive

Answer: C

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124. For which of the process, ΔS is negative?

A. $H_{2(g)} \rightarrow 2H_{(g)}$

B. $N_{2(g)}(1atm) \rightarrow N_{2(g)}(8atm)$

C. $2SO_{3(g)} \rightarrow 2SO_{2(g)} + O_{2(g)}$

D. $C_{(\text{diamond})} \rightarrow C_{(\text{graphite})}$

Answer: B

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125. The process of evaporation of a liquid is accompanised by

(A) Increase in enthalpy (B) Increase in entropy (C) Decrease in Gibbs energy

The correct statement(s) is/are

A. Only a and c

B. Only b and c

C. Only a and b

D. All

Answer: D

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126. The favourable conditions for a spontaneous reaction are

A. $T\Delta S > \Delta H, \Delta H = +ve, \Delta S = +ve$

B. $T\Delta S > \Delta H, \Delta H = +ve, \Delta S = -ve$

C. $T\Delta S = \Delta H, \Delta H = +ve, \Delta S = -ve$

D. $T\Delta S = \Delta H, \Delta H = +ve, \Delta S = +ve$

Answer: A

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127. A reaction has both DH and DS negative. The rate of reaction

A. Increases with increase of temperature

B. Increases with decrease of temperature

C. Remains unaffected by change of temperature

D. Cannot be predicted for change in temperature

Answer: A

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128. At $27^{\circ}C$ the reaction,

$C_6H_{6(l)}+\frac{15}{2}O_{2(g)}\to 6CO_{2(g)}+3H_2O((l))$ proceeds spontaneously because the magnitude of

A. $\Delta H=T\Delta S$

B. $\Delta H>T\Delta S$

C. $\Delta H<T\Delta S$

D. $\Delta H>0, T\Delta S<0$

Answer: B

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129. Although the dissolution of ammonium chloride in water is an endothermic reaction, even then it is spontaneous because

A. ΔH is positive, ΔS is negative

B. ΔH is positive, ΔS is zero

C. ΔH is positive, $T\Delta S < \Delta H$

D. ΔH is positive, ΔS is positive and $\Delta H < T\Delta S$

Answer: D

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130. For the precipitation reaction of Ag^+ ions with NaCl, which of the following statements is correct ?

A. ΔH for the reaction is zero

B. ΔG for the reaction is zero

C. ΔG for the reaction is negative

D. ΔG is equal to ΔH

Answer: C

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131. Which one of the following has ΔS^0 greater than zero?

A. $CaO_{(s)} + CO_{2(s)} \Leftrightarrow CaCO_{3(s)}$

B. $NaCl_{(q)} \Leftrightarrow NaCl_{(s)}$

C. $NaNO_{3(s)} \Leftrightarrow Na^{+}_{(aq)} + NO^{-}_{3(aq)}$

D. $N_{2(g)} + 3H_{2(g)} \Leftrightarrow 2NH_{3(g)}$

Answer: C

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132. For which of the following elements, the standard enthalpy is not zero?

A. C (Diamond)

B. C (Graphite)

C. Liquid mercury

D. Rhombic suphur

Answer: A

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133. The equilibrium constant of a reaction is 73. Calculate standard free energy change.

A. Both A & R are true and R is the correct explanation of A

B. Both A & R are true but R is not the correct explanation of A

C. A is true but R is false

D. A is false but R is true

Answer: D

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134. For a reaction $R_1, \Delta G = xKJmol^{-1}$. For a reaction $R_2, \Delta G = yKJmol^{-1}$. Reaction R_1 is non-spontaneous but along with R_2 it is spontaneous. This means that

A. x is -ve, y is +ve but in magnitude $x > y$

B. x is +ve, y is -ve but in magnitude $y > x$

C. Both x and y are -ve but not equal

D. Both x and y are +ve but not equal.

Answer: B

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135. Which of the following relationship is correct ?

A. $\Delta G^0 = -RT\ln K$

B. $K = e^{-\Delta G^0/RT}$

C. $K = 10^{-\Delta G^0/2.303RT}$

D. All of correct

Answer: D

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136. The least random state of H_2O system is

A. Ice

B. Liquid water

C. Steam

D. Randomness is same all.

Answer: A

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137. 

LIST-I	LIST-II
A) Work	1) Extensive property
B) Enthalpy	2) Intensive property
C) Temperature	3) State variable
D) P, V, T and n	4) Path function

The correct match is

The correct match is

A. $\begin{array}{ccc} A & B & C \\ 1 & 2 & 3 \end{array}$

B. $\begin{array}{ccc} A & B & C \\ 3 & 2 & 1 \end{array}$

C. $\begin{array}{ccc} A & B & C \\ 2 & 3 & 1 \end{array}$

D. $\begin{array}{ccc} A & B & C \\ 1 & 3 & 2 \end{array}$

Answer: B

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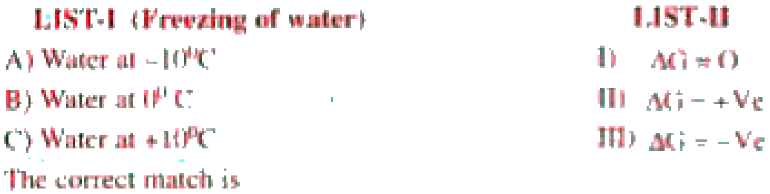
138. 

LIST-I (Freezing of water)	LIST-II
A) Water at -10^0C	I) $\Delta G = 0$
B) Water at 0^0C	II) $\Delta G = +Ve$
C) Water at $+10^0C$	III) $\Delta G = -Ve$

The correct match is

The correct match is

A. $\begin{array}{ccc} A & B & C \\ II & I & III \end{array}$

B. $\begin{array}{ccc} A & B & C \\ III & I & II \end{array}$

C. $\begin{array}{ccc} A & B & C \\ I & II & III \end{array}$

D. $\begin{array}{ccc} A & B & C \\ III & II & I \end{array}$

Answer: B

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139. For a spontaneous process, in a reaction

A. which needs some initaiation like heat or energy

B. which takes place instantaneously

C. which takes place by itself

D. takes place by itself or by initiation.

Answer: D

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140. When a system is in equilibrium state

A. Gas

B. Liquid

C. Solution

D. Solid

Answer: A

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141. $H_2O(l) \Leftrightarrow H_{2}O_{(s)}, \Delta H = -q$ application of pressure on this equilibrium

A. $G_{(ice)} = G_{(\text{water})} = 0$

B. $G_{(ice)} = G_{(\text{water})} \neq 0$

C. $G_{(ice)} > G_{(\text{water})}$

D. $G_{\text{ice}} < G_{(\text{water})}$

Answer: A

Watch Video Solution

142. The favourable conditions for a spontaneous reaction are

A. $\Delta H = -ve, \Delta S = +ve$

B. $\Delta H = +ve, \Delta S = -ve$

C. $\Delta H = -ve, \Delta S = -ve$

D. $\Delta H = +ve, \Delta S = +ve$

Answer: A

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143. For a process change in enthalpy is 36 kJ.mol and change in entropy is 120 J $\text{mole}^{-1}K^{-1}$. The temperature at which the sywstem attains eequibrium is

A. $50^{\circ}C$

B. $47^{\circ}C$

C. $27^\circ C$

D. $12^\circ C$

Answer: C

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144. ΔG_{sys} is equal to

A. $T\Delta S_{sys}$

B. $T\Delta S_{\text{total}}$

C. - $T\Delta S_{\text{total}}$

D. $\Delta S_{\text{sys}}\Delta S_{\text{surrounding}}$

Answer: C

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145. For $A_{(g)} + B_{(s)} \rightarrow 2C_{(g)}$, ΔH and ΔS respectively are 50 KJ and 100 J/K respectively. Then at $228^{\circ}C$

A. $\Delta G = 02$

B. $\Delta G > 0$

C. $\Delta G = 2$

D. $\Delta G < 0$

Answer: D

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146. First law of thermodynamics does not tell about

A. Law of conservatin of energy

B. Word done whether +ve (or) -ve

C. Feasibility of a process

D. ΔE at constant temperature

Answer: C

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147. For change in entropy, units are

A. mol/lit

B. mol. $lit^{-1}\sec^{-1}$

C. $J. mol^{-1}K^{-1}$

D. s^{-1}

Answer: C

Watch Video Solution

148. In standard state the non spontaneous reaction among the following is

A. Melting of ice

B. natural radioactiveity

C. Freezing of water

D. Rusting of iron

Answer: C

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149. If the u_{rms} of an ideal gas in a closed container is doubled, then which of the following statement correctly explains how the change is accomplished?

A. I,II

B. II,III

C. III,I

D. I,II,III

Answer: A

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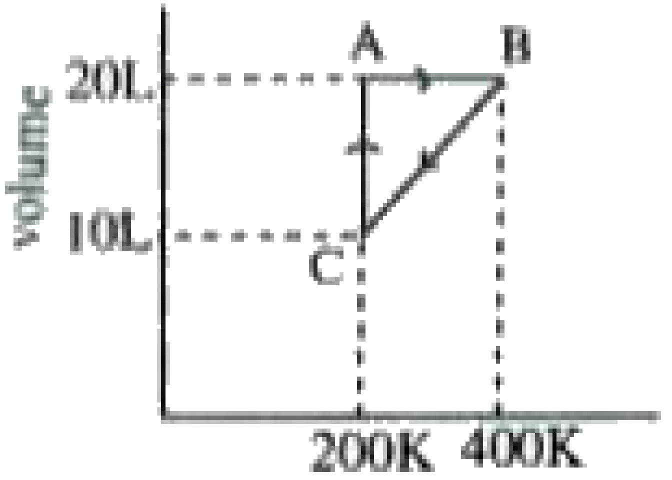
150.



Temperature

Graph for one moles gas

Process $A \rightarrow B$ represents

A. enthalpy for exothermic reactions

B. enthalpy for endothermic rreactions

C. entropy for exothermic reactions

D. entropy for endothermic reaction

Answer: B

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151. The correct statement regarding entropy is

A. At absolute zero temperaure, entropy of a perfectly crystalline solid is zero.

B. At absolute zero temperature, the entropy of a perfectly crystalline substance is +Ve.

C. At obsolute zero temperature, the entropy of all crystalline substance is zero.

D. At $0^{\circ}C$, the entropy of a perfect crystlline solid is zero.

Answer: A

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152. Identify the correct statements among the folowing

I) At equilibrium, change in entropy for a process, $DetlaS = 0$

II) Temperature is an extensive property

III)For a cyclic process $\Delta U \ne 0$

IV)During free expansion of a gas under reversible or irreversible condition $\Delta W = 0$

A. I & II

B. I & IV

C. II & III

D. I & III

Answer: B

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153. A reaction has both DH and DS negative. The rate of reaction

A. Increase with increase in temperature

B. Cannot be predicted for change in temperature

C. Increase with decrease in temperature

D. Remains unaffected by change in temperature

Answer: C

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OBJECTIVE EXERCISE-2

1. A system absorbs 600J of energy and does work equivalent to 400J J of energy. The internal energy changes

A. 1000J

B. 200 J

C. 600J

D. 300J

Answer: B

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2. During a process work equivalent to 400J is done on a system, which gives out of 125J of energy. The change in internal energy is

A. 525J

B. 375J

C. 275J

D. 200J

Answer: C

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3. One litre-atmosphere is appromixmately equal to

A. $19.2KJ$

B. $101J$

C. $8.31J$

D. $831J$

Answer: B

Watch Video Solution

4. One mole of an ideal gas at 300K is expanded isothermally reversibly from an initial volume of 1 litre to 10 litres. The ΔE for this process is (R = 2 cal $mol^{-1}K^{-1}$)

A. $163.7cal$

B. Zero

C. $1381.1cal$

D. 9 lit atm

Answer: B

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5. An ideal gas occuping a volume of $2dm^3$ and a pressure of 5 bar undergoes isothermal and irreversible expansion against external pressure of 1 bar. The final volume of the system and work involved in the process is

A. $10dm^3, 1000J$

B. $8dm^3, -800J$

C. $10dm^3, -800J$

D. $10m^3, -1000J$

Answer: C

Watch Video Solution

6. A system absorbs 10kJ of heat at constant volume and its temperature rises from $27^\circ C$ to$37^\circ C$. The ΔE of reaction is

A. $100KJ$

B. $10kJ$

C. 0

D. 1KJ

Answer: B

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7. An ideal gas expands in volume from $10^{-3}m^3$ to $10^{-2}m^3$ at 300 K against a constant pressure of 10^5Nm^{-2}. The work done is

A. $-900J$

B. $900KJ$

C. $270KJ$

D. $-900KJ$

Answer: A

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8. Two moles of an ideal gas is expanded spontaneously into a vacuum. The work done is

A. Zero

B. 2J

C. 4J

D. 8J

Answer: A

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9. A gas absorbs 250 J of heat and expands from 1 litre to 10 litre at constant temperature against external pressure of 0.5 atm . The values of q, w and ΔE will be respectively.

A. $10cm^3, 500J$

B. 10^3dm^3, - $510J$

C. $10dm^3, 1010J$

D. $5dm^3$, - $1010J$

Answer: D

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10. The internal energy change when a system goes from state A to B is 40 KJ/mole. If the system goes from A to B by a reversible path and returns to state A by an irreversible path what would be the net change in internal energy ?

A. $40KJ$

B. $> 40KJ$

C. $< 40KJ$

D. Zero

Answer: D

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11. The work done when 65.38g of zinc dissolved completely in HCl in an open beaker at 300k

A. $-2494.2J$

B. $-249.4J$

C. $1J$

D. $-24.94J$

Answer: A

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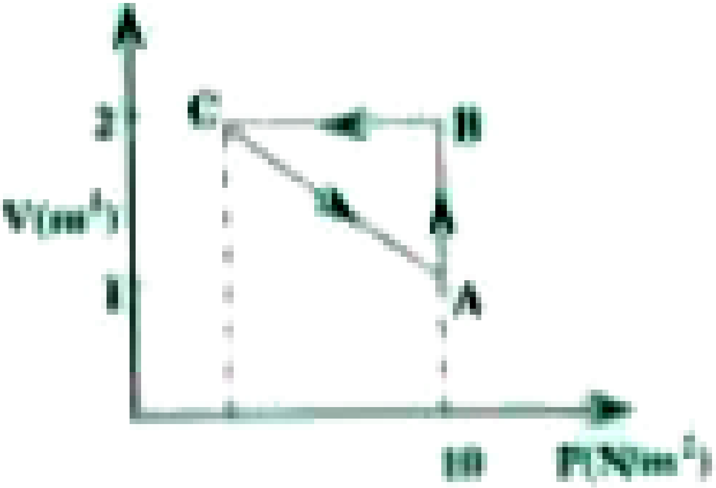
12. An ideal gas is taken through the cycle $A \rightarrow B \rightarrow C \rightarrow A$, as shown in the figure. If the net heat supplied to the gas in the cycle is 5 J, what is the work done by the gas in the process $C \rightarrow A$



A. $-5J$

B. $-10J$

C. $-15J$

D. $-20J$

Answer: A

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13. Latent heat of vapourisation of a liquid at 500k and 1atm pressure is 10K. Cal/mole. What is the change in internal energy when 3 moles of the liquid is vapourised at the same temperature

A. $27K. Cal$

B. $7K. Cal$

C. $33K. Cal$

D. $25K. Cal$

Answer: A

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14. The molar heat capacity of water at constant pressure, C, is $75JK^{-1}mol^{-1}$. When 1.0KJ of heat is supplied to 100g of water which is free to expand, the increase in temperature of water is :

A. $1.4K$

B. $2.4K$

C. $4.8K$

D. $6.6K$

Answer: B

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15. For an ideal gas, $\left(\frac{\partial E}{\partial V}\right)_T$ is

A. zero

B. $+Ve$

C. $-Ve$

D. ΔH

Answer: A

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16. For a gas having molar mass M, specific heat at constant pressure can be given as:

A. $\frac{\gamma R}{M(\gamma - 1)}$

B. $\frac{\gamma}{RM}$

C. $\frac{M}{R(\gamma - 1)}$

D. $\frac{\gamma RM}{\gamma + 1}$

Answer: A

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17. Molar heat capacity of water in equilibrium with ice at constant pressure is:

A. Zero

B. Infinity (∞)

C. $40.45 KJK^{-1} mol^{-1}$

D. $5.48 JK^{-1} mol^{-1}$

Answer: B

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18. Molar heat capacity $\left(C_p\right)$ of water of constant pressure is $75 JK^{-1} mol^{-4}$. The increase in temperature (in K) of 100g of water when I kJ of heat is supplied to it is

A. $1.8 \times 10^{-3} mol$

B. 3.6×10^{-5} mol

C. $0.0288g$

D. $0.288mg$

Answer: D

Watch Video Solution

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19. Temperature of 1 mole of an ideal gas is increased from 300 K to 310 K under isochoric process. Heat supplied to the gas in this process is Q = 25 R, where R = universal gas constant. What amount of work has to be done by the gas if temperature of the gas decreases from 310 K to 300 K adiabatically?

A. 16X

B. $6.25X$

C. 32X

D. $12.5X$

Answer: D

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20. Change in enthalpy when $11.2dm^3$ of He at NTP is heated in a cylinder to $100\ ^\circ C$ is

A. $623.5J$

B. $1039.25J$

C. $1227J$

D. $520J$

Answer: B

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21. On which of the following factors does internal energy depend upon

A. $q = 500J, W200J$

B. $1 = -400J, W = +200J$

C. $q = 500J, W = 200J$

D. $q = 400J, Q = 100J$

Answer: C

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22. Which of the one following is not a state function ?

A. ΔH

B. ΔS

C. S

D. W

Answer: B

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23. A gas absorbs 250 J of heat and expands from 1 litre to 10 litre at constant temperature against external pressure of 0.5 atm . The values of q, w and ΔE will be respectively.

A. $250J, 455J \text{ and } 710J$

B. $250J, -455J \text{ and } -205J$

C. $-250J, -455J \text{ and } -205J$

D. $-250, 455J \text{ and } 205J$

Answer: C

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24. Heat of combustion of C_2H_4 is -337 kCal. If 5.6 lit O_2 is used at STP, in the combustion heat liberated is ____ kCal

A. 28.08

B. 14.04

C. 42.06

D. 56.16

Answer: A

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25. Human body requires 2370 K. Cal of energy daily. The heat of combustion of glucose is -790 K.cal/mole. The amount of glucose required for daily consumption is

A. 650g

B. 540g

C. 327g

D. 490.5g

Answer: B

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26. The heats of combustion of ethane, ethene and acetylene are -341.1 kcal, -330 kcal and -310.9 kCal mol^{-1} respectively. The best fuel among them is

A. Ethane

B. Ethene

C. Acetylene

D. All are equal

Answer: C

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27. The heat of combustion of benzene at $27^\circ C$ found by bomb calorimeter i.e., for the reaction $C_6H_6\_((l)) + 7\frac{1}{2}O_{2(g)} + 6CO_{2(g)} + 3H_2O_{(l)}$ is $-780K. Calmol^{-1}$. The heat evolved on burning 39g of benzene in an open vessel will be

A. 390 K.Cal

B. $780.9K. Cal$

C. $390.45K. Cal$

D. $780K. Cal$

Answer: C

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28. $N_2 + 3H_2 \rightarrow 2NH_3, \Delta H = $ - $46K$. Cals. From the above reaction, heat of formation of ammonia is

A. 46 K.Cal

B. - $46K$. Cals

C. - 23K.Cals

D. 23` K.Cals

Answer: C

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29. Given that $\frac{1}{2}S_{8(s)} + 6O_{2(g)} \rightarrow 4SO_{3(g)}, \Delta H^0 = -1590kJ.$ The standard enthalpy of formation of SO_3 is

A. $-1590KJmol^{-1}$

B. $-397.5kJmol^{-1}$

C. $-3.975KJmol^{-1}$

D. $+397.5KJmol^{-1}$

Answer: B

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30. The amount of heat evolved on combustion of 10 grams of benzoic acid is 10 K.Cals. The heat of combustion of benzoic acid is

A. $-122K.$ Cals

B. -122K.Cals

C. -132 K.Cals

D. -92 K.Cals

Answer: A

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31. The heat of reaction at constant volume and temperature is represented by

A. -160

B. -320

C. -1600

D. 1600

Answer: C

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32. The heat of combustion of solid benzoic acid at constant volume is $-321.30KJ$ at $27\,^{\circ}C$. The heat of combustion at constant pressure is

A. $-321.30-300R$

B. $-321.30+300R$

C. $-321.30-150R$

D. $-321.30+900R$

Answer: C

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33. For the reaction $2H_2O_{(l)} \rightarrow H_3O^{+}_{(aq)} + OH^{-}_{(aq)}$, the value of ΔH is

A. $114.6KJ$

B. $-144.6KJ$

C. $57.3KJ$

D. $-57.3KJ$

Answer: C

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34. (A): Pyrolusite is an ore of manganese.

(R) : Formula of pyrolusite is Mn_3O_4.

A. $624.67KJ$

B. $462.67KJ$

C. $476.67KJ$

D. $426.67KJ$

Answer: B

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35. Heat liberated in the neutralisation of 500 ml of 1N HCl and 500ml of 1N NH_4OH is -1.36 K.Cals. The heat of ionisation of NH_4OH is

A. 10.98K.Cals

B. -12.34 K.Cals

C. -10.98K.Cals

D. 12.34 K.Cals

Answer: A

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36. When 1 litre of IM HCl is mixed with 1 litre of 1M NaOH, the rise in temperature was found to be T_1. In another experiment 1 litre of 0.5 M NaOH is mixed with 1 lit. of 0.5 M HCl. The rise in temperature was found to be T_2. Then

A. $T_1 = T$

B. $T_1 < T_2$

C. $T_1 = 2T_2$

D. $T_2 = 2T_1$

Answer: C

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37. $H_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}, \Delta H$ for the above reaction is

A. -13.7K.Cal

B. +57.3K.J

C. -27.4K.Cal

D. -137K.J

Answer: C

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38. Equal volumes of equi molar HCl and H_2SO_4 are separately neutralised by dilute NaOH solution, then heats liberated and x kCal and y kCal respectively. Which of the following is true.

A. $x = y$

B. $x = y/2$

C. $x = 2y$

D. $x = y/3$

Answer: B

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39. When $50cm^3$ of 0.2N H_2SO_4 is mixed with $50cm^3$ of 1N KOH, the heat liberated is

A. $11.45KJ$

B. $57.3KJ$

C. $573KJ$

D. $573J$

Answer: D

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40. Heat of neutralisation for the reaction $NaOH + HCl \rightarrow NaCl + H_2O$ is $-57.1kJ\text{mole}^{-1}$. The heat relased when 0.25 moles of NaOH is treated with 0.25 moles of HCl is

A. 22.5 K.J/mole

B. 57.1 K.J/mole

C. 14.3 K.J/mole

D. 28.6K.J/mole

Answer: C

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41. The heats of neutralisation of HCl with NH_4OH and that of NaOH with CH_3COOH are repectively -51.4 and $-50.6 KJeq^{-1}$. The heat of neutralisation of acetic acid with NH_4OH will be

A. $-44.6 KJeq^{-1}$

B. $-50.6 KJeq^{-1}$

C. $-51.4 KJeq^{-1}$

D. $-57.4 KJeq^{-1}$

Answer: A

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42. Given that the data for neutralization of a weak acid (HA) and strong acid with a strong base is:

$HA + OH^- \Rightarrow A^- + H_2O : \Delta H = -41.80kJ, H^+ + OH^- \Rightarrow H_2O, \Delta H = -55.90kJ$

The enthalpy of dissociation of weak acid would be

A. $-97.20KJ$

B. $+97.70KJ$

C. $-14.10KJ$

D. $14.10KJ$

Answer: D

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43. $H_2SO_{4(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + 2H_2O_{(l)}, \Delta H$ for the above reaction is

A. 13.6

B. 6.8

C. 27.2

D. 2.72

Answer: C

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44. 20 ml of 0.4 MH_2, SO_4 , and 80 ml of 0.2 M NaOH are mixed. Then the p^H of the resulting solution is

A. 9

B. 36

C. 27

D. 18

Answer: A

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45. In which of the following combinatins of HCL and NaOH, the heat energy liberated is maximum

A. 10 ml of 0.1 M HCl + 40 ml of 0.1 M NaOH

B. 30 ml of 0.1 M HCl + 20 ml of 0.1 M NaOH

C. 25ml of 0.1 M HCl + 25 ml of 0.1 M NaOH

D. 35ml of 0.1 M HCl + 15 ml of 0.1 M NaOH

Answer: C

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46. The enthalpy of the reaction $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}$ is ΔH_1 and that of $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)} is \Delta H_2$. Then

A. 491.5

B. 495.1

C. 419.5

D. 415.9

Answer: A

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47. Heat of combustion of benzoic acid $\left(C_6H_5COOH\right)$ at constant volume at $25^{\circ}C$ is $-3233KJ/\text{mole}$. When 0.5g of benzoic acid is burnt in bomb calorimeter, the temperature of calorimeter increased by $0.53^{\circ}C$. Now in the same bomb calorimeter 1g of C_2H_6 burnt then temperature increased by $2.04^{\circ}C$. ΔH for combustion of $C_2H_6$is

A. -1530 KJ/mole

B. -1536.2 KJ/mole

C. $-1522.8KJ$/mole

D. $+1536.2KJ/\text{ mole}$

Answer: B

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48. The heat of atomisation of $PH_{3(g)}$ is $118K.\ Calmol^{-1}$ and that of $P_2H_{4(g)} is 355K.\ Calmol^{-1}$ The energy of the P-P bond is (in K.Cal),

A. 102

B. 51

C. 26

D. 204

Answer: B

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49. $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}, \Delta H = -286.2KJ$

$H_2O_{(l)} \rightarrow H^{+}_{(aq)} + OH^{-}_{(aq)}, \Delta H = +57.3KJ$

Enthalpy of ionization OH^- in aqueons solution is

A. $-228.5KJ$

B. $+228.5KJ$

C. $-343.5KJ$

D. zero

Answer: A

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50. Among the following ions, for which one standard enthalpy of ionisation is zero

A. $OH^-_{(aq)}$

B. $Cl^-_{(aq)}$

C. $H^-_{(aq)}$

D. $H^+_{(aq)}$

Answer: D

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51. $\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightarrow HCl_{(g)}, \Delta H^0 = -92.4$ kJ/mole, $HCl_{(g)} + nH_2O \rightarrow H^+_{(aq)} + Cl^-_{(aq)}, \Delta H^0 = -74.8$ kJ/mole $\Delta H^0 f$ for $Cl^-_{(aq)}$ is

A. -17.6 KJ/mole

B. -167.2 KJ/mole

C. $+17.6$KJ/mole

D. -35.2 KJ/mole

Answer: B

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52. Work done during the combustion of one mole of CH_4 in bomb calorimeter is

A. zero

B. - $101J$

C. - $24.2J$

D. - $1J$

Answer: A

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53. A sample of CH_4 of 0.08g was subjected to combustion at $27^\circ C$ in a bomb calorimeter. The temperature of the calorimeter system was found to be raised by $0.25^\circ C$. If heat capacity of calorimeter is $18kJ/^\circ C$, ΔH for combustion of CH_4 at $27^\circ C$ is

A. - 900 KJ/mole

B. -950KJ/mole

C. -859KJ/mole

D. -890KJ/mole

Answer: B

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54. For the reaction of one mole zinc dust with one mole sulphuric acid in a bomb calorimeter, ΔU and w correspond to

A. $\Delta U > 0, w = 0$

B. $\Delta U < 0, w < 0$

C. $\Delta U > 0, w = 0$

D. $\Delta U > 0, w > 0$

Answer: A

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55. The dissociation energy of CH_4 is $400K.\ Calmol^{-1}$ and that of ethane is $670K.\ Calmol^{-1}$. The C-C bond energy is:

A. 270 K.Cal

B. 70 K.Cal

C. 200 K.Cal

D. 240 K.Cal

Answer: B

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56. $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}, \Delta H = -ve$ and $\Delta G = -ve$ then the reaction is

A. $-q_1 - \left[-q_2 - q_3\right]$

B. $\left[-q_2 - q_3\right] + q_1$

C. $-q_1 - q_2 - q_3$

D. $q_1 + q_2 + q_3$

Answer: B

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57. ΔH_f or $BaCO_{3(s)}, CO_{2(g)}, HCl_{(aq)}$ and $H_2O_{(l)}$ respectively are $-1216, -393, -176$ and $-286KJ/mol.$ Then ΔH_f of $BaCl_{2(aq)}$ from $BCo_{3(s)} + 2HCl_{(aq)} \rightarrow BaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$'$\Delta H = -QKJ$

A. $(889 - Q)KJ$

B. $(Q + 889)KJ$

C. $-(Q + 889)KJ$

D. $(Q - 889)KJ$

Answer: C

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58. Given

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -395kJ, S_{(g)} + O_{2(g)} \rightarrow SO_{2(g)}, \Delta H = -295$

$CS_{2(l)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{2(g)}, \Delta H = -1110kJ$

The heat of formation of $CS_{2(l)}$ is

A. $+3043KJ$

B. $-3043KJ$

C. $-2925KJ$

D. $-2984KJ$

Answer: B

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59. Given

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -395kJ, S_{(g)} + O_{2(g)} \rightarrow SO_{2(g)}, \Delta H = -295$

$CS_{2(l)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{2(g)}, \Delta H = -1110kJ$

The heat of formation of $CS_{2(l)}$ is

A. $+125KJmol^{-1}$

B. $31.25KJmol^{-1}$

C. $62.5KJmol^{-1}$

D. $250kJmol^{-1}$

Answer: A

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60. 1)$C_{\text{Graphite}} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -94K.Cals$

2) $C_{\text{Diamond}} + O_{2(g)} \rightarrow CO_{2(g)}, \Delta H = -94.5K.Cals$

From the above data the heat of transition of $C_{\text{diamond}} \rightarrow C_{\text{Graphite}}$

A. -50 Cal

B. -100 Cal

C. -500 Cal

D. 100 Cal

Answer: C

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61. ΔH of combustion of yellow P and red P are `- 11 K.J and -9.78 KJ respectively DeltaH of transition of yellow P to Red P is

A. $-20.78K.\ J$

B. $-1.22K.\ J$

C. $+1.22K.\ J$

D. $+20.78K.\ J$

Answer: B

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62. How much energy is released when 6 mole of octane is burnt in air? Given ΔH_f^0 for $CO_{2(g)}, H_2O_{(g)}$ and $C_8H_{18(l)}$ respectively are $-390, -240$ and $+160$ KJ/mol

A. $-32.6MJ$

B. $-37.4MJ$

C. $-35.5MJ$

D. $-20.0MJ$

Answer: A

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63. Given

$C+2S \rightarrow CS_2, \Delta Hf^0 = +117.0KJmol^{-1}, C+O_2 \rightarrow CO_2, \Delta Hf^0 = -393.0KJmol$

. The heat of combustion of $CS_2+3O_2 \rightarrow CO_2+2SO_2$ is

A. $-807KJmol^{-1}$

B. $-1104 KJmol^{-1}$

C. $+110 KJmol^{-1}$

D. $+807 KJmol^{-1}$

Answer: B

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64. The reaction which shows standard heat of formation of water correctly is

A. $-251.9 KJ$

B. $241.9 KJ$

C. $-241.9 KJ$

D. $301.9 KJ$

Answer: C

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65. The lattice energy of solid NaCl is 180K. Call per mol. The dissolution of the solid in water in the form of ions is endothermic to the extent of 1K, Cal per mol. If the solvation energies of Na^+ and Cl^- ions are in ratio $6:5$, what is the enthalpy of hydration of sodium ion?

A. $-85.6K$.Cal/mol

B. $-97.5K$. Cal/mole

C. $82.6K$. Cal/mol

D. $+100K$. Cal/mol

Answer: B

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66. Heat of formation of CO and CO_2 are -26.4, -94.0 kcal/mole respectively. What is the heat of combustion of CO in kcals?

A. $+26.4$

B. 120.6

C. -67.6

D. 135.2

Answer: C

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67. $Cl_{(g)} + e^{-} \rightarrow Cl^{-}_{(g)}, E_A = -348kJ/\text{mole}$ at 0 K. then ΔH for same process at 300K (in kJ) [R=8J/mol/K] [Hint : $\Delta H = EA - \frac{5}{2}RT$].

A. $+354$

B. $+348$

C. -354

D. Zero

Answer: C

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68. For the reaction:

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}, \Delta H = -571kJ$

bond energy of (H-H) = 435 kJ, of (O = O) = 498kJ , then the average bond energy of O-H bond using the above data

A. 484KJ

B. $-84KJ$

C. 271kJ

D. $-271kJ$

Answer: A

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69. If values of ΔH_f° of $ICl_{(g)}, Cl_{(g)}$ and $I_{(g)}$ are respectively $17.57, 121.34, 106.96 Jmol^{-1}$. The value of $I - Cl$ (bond energy) in $Jmol^{-1}$ is:

A. 17.57

B. 210.73

C. 35.15

D. 106.96

Answer: B

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70. If the standard molar enthalpy of formation of $CaO_{(s)}, CO_{2(s)}$ and $CaCO_{3(s)}$ is $-635, -393$ and $-1207kJ\text{mol}^{-1}$ respectively, the $\Delta_r H^{\odot}$ in $kJmol^{-1}$ for the reaction $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ is

A. -179

B. 265

C. 223.5

D. $+179$

Answer: D

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71. If $S + O_2 \rightarrow SO_2, \Delta H = -398.5kJ$

$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3, \Delta H = -98.7kJ, SO_3 + H_2O \rightarrow H_2SO_4, \Delta H = -130.5kJ$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O, \Delta H = -227.3kJ$

If magnitude of enthalpy of formation of sulphuric acid at 298K is 95x, x= ?

A. $Q_2 = Q_1(-Q_3) = -Q_4$

B. $-Q_2 = Q_1 - 2Q_3 - Q_4$

C. $Q_1 + Q_2 = -(Q_3 + Q_4)$

D. $Q_1 - Q_4 = Q_2 - Q_3$

Answer: B

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72. $C_2H_{6(g)} + 3.5O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$

$\Delta S_{\text{vap}}\left(H_2O, l\right) = x_1 \text{ cal}K^{-1}$ (boiling point is T_1)

$\Delta H_f\left(H_2O, l\right) = x_2, \Delta H_f\left(CO_2\right) = x_3, \Delta H_f\left(C_2H_6\right) = x_4$ Hence ΔH for the reaction is

A. $-295.96KJ$

B. $+295.96KJ$

C. $-296.04KJ$

D. $-296.32KJ$

Answer: C

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73. The enthalpy of the reaction $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}$ is ΔH_1 and that of $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)} is \Delta H_2$. Then

A. -163

B. 788

C. 394

D. -81.5

Answer: A

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74. The enthalpies of HCl, NaOH ,NaCl and H_2O are $-120, -82, -148$ and -68 kCals. Respectively. ΔH of the following reaction is $HCl + NaOH \rightarrow NaCl + H_2O$

A. -28.7K.Cals

B. -18 k.Cals

C. -57.3 K.Cals

D. -14 K.Cals

Answer: D

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75. ΔH^0 for a reaction $F_2 + 2HCl \rightarrow 2HF + Cl_2$ is given as $-352.8kJ$. ΔH_f^0 for HF is $-268.3KJmol^{-1}$, then ΔH_f^0 of HCl would be

A. $-22KJmol^{-1}$

B. $880kJmol^{-1}$

C. $-91.9kJmol^{-1}$

D. $-183.8kJmol^{-1}$

Answer: C

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76. What is theheat of formation of C_6H_6, given that the heats of combustion of benzene, carbon and hydrogen are 782, 94 and 68K. Cal respectively

A. $+14$K.Cal

B. -14 K.Cal

C. $+28$ K.Cal

D. -28 K.Cal

Answer: A

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77. The heats of combustion of carbon hydrogen and acetylene are $-394kJ$, $-286kJ$ and $-1301kJ$ respectively. Calculate heat of formation of C_2H_2

A. $621K.J$

B. $454K.J$

C. $-227K.J$

D. $227K. J$

Answer: D

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78. The standard enthalpies of formation of $H_2O_{2(l)}$ and $H_2O_{(l)}$ are $-187.8kJ\text{mole}^{-1}$ and $-285.8kJ\text{mole}^{-1}$ respectively. The ΔH^0 for the decomposition of one mole of $H_2O_{2(l)}$ to $H_2O_{(l)}$ and $O_{2(g)}$ is

A. $-473.6K. J. \text{mole}^{-1}$

B. $-98.0K. J. \text{mole}^{-1}$

C. $+473.6K. J. \text{mole}$

D. $+187.8K. J. \text{mole}^{-1}$

Answer: B

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79. The enthalpies of combustion of carbon and carbon monoxide are $-390 KJmol^{-1}$ and $-278 KJmol^{-1}$ respectively. The enthalpy of formation of carbon monoxide is

A. $668 KJmol^{-1}$

B. $112 KJmol^{-1}$

C. $-112 KJmol^{-1}$

D. $-668 KJmol^{-1}$

Answer: C

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80. Calculate the heat of formation of KOH from the following data

$$K_{(s)} + H_2O + aq \rightarrow KOH_{(aq)} + \frac{1}{2}H_{2(g)}, \Delta H = -48.4 K. Cal$$

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}, \Delta H = -68.44 K. Cal$$

$$KOH_{(s)} + aq \rightarrow KOH_{aq}, \Delta H = -14.01 K. Cal$$

A. $+102.83$

B. $+130.85$

C. -102.83

D. -130.85

Answer: C

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81. $N_{2(g)} + 2O_{2(g)} \rightarrow 2NO_2 + xkJ, 2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)} + ykJ.$

The enthalpy of formation of NO is

A. $(2X - 2Y)$

B. $X - Y$

C. $1/2(Y - X)$

D. $1/2(X - Y)$

Answer: C

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82. If $S + O_2 \rightarrow SO_2, \Delta H = -398.5kJ$

$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3, \Delta H = -98.7kJ, SO_3 + H_2O \rightarrow H_2SO_4, \Delta H = -130.5kJ$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O, \Delta H = -227.3kJ$

If magnitude of enthalpy of formation of sulphuric acid at 298K is 95x, x= ?

A. $-854.4K.J$

B. $-754.4K.J$

C. $-650.3K.J$

D. $-433.7K.J$

Answer: A

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83. For the reaction $2H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$, the value of ΔH is

A. $+348KJ$

B. $-348KJ$

C. $-174KJ$

D. $+87KJ$

Answer: A

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84. Let M_1 and M_2 be the masses of the nuclei $_1H^2$ and $_2H^4$ respectively. Aslo let m_p and m_n be the masses of proton and neutron respectively.

A. -87

B. -170

C. $+170$

D. Zero

Answer: B

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85. If the heats of formation of Al_2O_3 and Fe_2O_3 are -400 K.Cal and -190 K.Cal respectively, the heat of the following reaction is

$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$

A. $210K. Cal$

B. $590K. Cal$

C. $-590K. Cal$

D. $-210K. Cal$

Answer: D

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86. $C_6H_6 \rightarrow C_6H_{12}, \Delta H = -204KJ.$ Heat of hydrogenation of each C=C (assumed to be) in benzene is [in KJ]

A. -68

B. -612

C. -204

D. -34

Answer: A

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87. $Zn_{(s)} + Cu^{+2}_{(aq)} \rightarrow Cu_{(s)} + Zn^{+2}_{(aq)}$,

$\Delta G = -XKJ, Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow 2Ag_{(s)} + Cu^{+2}_{(aq)}$,

$\Delta G = -YKJ$, then

ΔG for $Zn_{(s)} + 2Ag^{+}_{(aq)} \rightarrow 2Ag_{(s)} + Zn^{+2}_{(aq)}$ will be (in KJ)

A. $-82KJ$

B. $-22KJ$

C. $+226KJ$

D. Zero

Answer: A

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88. Calculate ΔH° for the reaction :

$Na_2O + SO_3 \rightarrow Na_2SO_4$ given the following :

A) $Na_{(s)} + H_2O(1) \rightarrow NaOH_{(s)} + \frac{1}{2}H_{2(g)}, \Delta H^\circ = -146kJ$

B) $Na_2SO_{4(s)} + H_2O(1) \rightarrow 2NaOH_{(s)} + SO_{3(g)}, \Delta H^\circ = +418kJ$

C) $2Na_2O_{(s)} + 2H_{2(g)} \rightarrow 4Na_{(s)} + 2H_2O_{(l)}, \Delta H^\circ = +259$ kJ

A. $+823KJ$

B. $-580.5KJ$

C. $-435KJ$

D. $+531KJ$

Answer: B

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89. Given that

$$S_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow SO_{3(g)} + 2xK.\,cal$$

$$SO_{2(g)} + ½O_{2(g)} \rightarrow SO_{3(g)} + yK.\,Cal.$$

Which would be the enthalpy of formation SO_2 ?

A. $(2x - y)$

B. $(2x + y)$

C. $(y - 2z)$

D. $\frac{2x}{y}$

Answer: C

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90. If the standard molar enthalpy of formation of $SO_{2(g)}$ and $SO_{3(g)} is - 296.82kJmol^{-1}$ and $- 395.72kJmol^{-1}$ respectively, then enthalpy change for the reaction in $kJmol^{-1}, SO_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow SO_{3(g)}$, is

A. -296.82

B. $+98.9$

C. -395.72

D. -98.9

Answer: D

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91. If the bond energies of H-H, Br-Br and HBr are $433, 192 \text{ and } 364kJmol^{-1}$ respectively, then ΔH° for the reaction :

$H_{2(g)} + Br_{2(g)} \rightarrow 2HBr_{(g)}$ is

A. $-261kJ$

B. $+103kJ$

C. $+261kJ$

D. $-103kJ$

Answer: D

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92. The standard free energy of $Cu^{+}_{(aq)}$ is $50 kJ mol^{-1}$ and that of $Cu^{2+}_{(aq)}$ is $66 kJ. mol^{-1}$. Calculate the change in free energy for the reaction, $Cu^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + e^{-}$.

A. -16

B. $+116$

C. -116

D. $+16$

Answer: D

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93. ΔSf or $4Fe_{(s)} + 3O_{2(g)} \rightarrow 2Fe_2O_{3(s)}$ is -550 J/mole/K.The process is found to be spontaneous even at 298K because $[\Delta H = -1660kJ]$

A. $\Delta S_{\text{total}} = -2000J$

B. $\Delta S_{\text{total}} = +1650J$

C. $\Delta S_{\text{total}} = +4980J$

D. $\Delta S_{\text{total}} = -4980J$

Answer: C

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94. $A \Leftrightarrow B, K = 8 - - - (I)$

$B \Leftrightarrow C, K, = 10 - - - (II)$

$C \Leftrightarrow D, K = 0.01 - - - (III)$

The correct order ofΔG values of processes at the same temperature is

A. $III > I > II$

B. $III > I > \quad = II$

C. $I > III > II$

D. $II > I > III$

Answer: A

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95. ΔS for vapousization of 900 g water (in KJ//K) is $\left[\Delta H_{vap} = 40KJ/mol\right]$

A. (900×40)

B. $\dfrac{50 \times 40}{373}$

C. $\dfrac{900 \times 40}{373}$

D. $\dfrac{18 \times 40}{373}$

Answer: B

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96. ΔS_{surr} for $H_2 + 1/2O_2 \rightarrow H_2O, \Delta H$ - $280kJ$ at 400K is

A. 700 J/g/K

B. 700 KJ/mol/J

C. 700 J/mol/K

D. $0.7J/mol/K$

Answer: C

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97. For a certain reaction, ΔH^0 & ΔS^0 respectively are 400kJ & 200 J/mol/K. The process is non-spontaneous at

A. 2100 K

B. 2010 K

C. 1990 K

D. 2020 K

Answer: C

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98. Enthalpy of vapourisation for water is 186.5 KJ mole^{-1}. The entropy change during vapourisation is ____ $KJ\text{mole}^{-1}$

A. 0.5

B. 1.0

C. 1.5

D. 2.0

Answer: A

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99. One mole of ice is converted into water at 273 K. The entropies of $H_2O_{(s)}$ and $H_2O_{(l)}$ are 38.20 and $60.01 Jmol^{-1}K^{-1}$ respectively. The enthalpy change for the conversion is

A. `595.4 J ml ^(-1)

B. `59.54 J mol ^(-1)

C. $320.6 Jmol^{-1}$

D. $595 Jmol^{-1}$

Answer: D

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100. One of the following reactions involves in decrease of entropy

A. Sublimation of dry ice

B. Crystallisation of salt from brine (aq)

C. Burning of rocket fuel

D. Decomposition of gaseousN_2O_4.

Answer: B

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101. $S^0_{H_{2(g)}} = 130.6JK^{-1}mol^{-1}, S^0_{H_2O_{(l)}} = 69.9JK^{-1}mol^{-1}, S^0_{O_{2(g)}} = 205JK^{-1}$,

Then the absolute entropy change of $H_{2(g)} + \frac{1}{2}O_{2(g)} \to H_2O_{(l)}$ is

A. $-163.2Jmol^{-1}K^{-1}$

B. $+163.2Jmol^{-1}K^{-1}$

C. $-303Jmol^{-1}K^{-1}$

D. $+303Jmol^{-1}k^{-1}$

Answer: A

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102. Standard entropies of$H_2(g)$, $O_2(g)$ and $H_2O(l)$ are respectively 126.6, 201.2 and $68JK^{-1}mol^{-1}$ Determine ΔS for $2H_2(g) + O_2(g) \to 2H_2O(l)$ at $25^\circ C$.

A. -574

B. $+574$

C. $+1148$

D. -1148

Answer: A

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103. The equilibrium constant for a reaction is 10. What will be the value of ΔG^{θ}?

$R = 8.314JK^{-1}mol^{-1}, T = 300K.$

A. -2.872

B. -5.744

C. -11.488

D. 8.572

Answer: B

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104. For a reaction the ΔS value is $-20 Jmol^{-1}k^{-1}$. If the temperature is increased from $0^{\circ}C$ at $25^{\circ}C$, the increases in the value of ΔG is (in J mol^{-1})

A. 500

B. -500

C. 0

D. 14900

Answer: A

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105. Mg^{2+} and Al^{3+} have same

A. $+505.6$

B. -505.6

C. -1011.2

D. $+1011.2$

Answer: B

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106. For the reaction $A \rightarrow B, \Delta E = 85kJmol^{-1}$, if the system proceeds from A to B by a reversible path and returns to A by an irreversible path , the net change in internal energy (in KJ) is

A. 170

B. zero

C. 42.5

D. unpredicatable

Answer: B

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107. Which property is common in diamond and graphite ?

A. -2.9

B. $+2.9$

C. $+5.8$

D. -5.8

Answer: C

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108. The entropy value at temperature T is

A. $S=\int_o^T C_P.\,dT$

B. $S = \int_o^T C_P . TdT$

C. $S = \int_o^T \frac{C_P}{T} . dT$

D. $S = \int_o^T C_P . T^3 dT$

Answer: C

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109. In the vicnity of absolute zero , the value of C_p - C_v is

A. R

B. zero

C. aT^3

D. $3/2RT$

Answer: B

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110. In a reversible reaction at equilibrium the net heat change of the reaction is :

A. Positive

B. Negative

C. Zero

D. Cannot be predicated

Answer: C

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111. $S^0_{H_{2(g)}} = 130.6JK^{-1}mol^{-1}, S^0_{H_2O_{(l)}} = 69.9JK^{-1}mol^{-1}, S^0_{O_{2(g)}} = 205JK^{-1}$,

Then the absolute entropy change of $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$ is

A. $-163.2Jmol^{-1}K^{-1}$

B. $+163.2Jmol^{-1}K^{-1}$

C. $-303Jmol^{-1}K^{-1}$

D. $+303 mol^{-1}K^{-1}$

Answer: A

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112. At $0^{\circ}C$ ice and water are in equilibrium and $\Delta H = 6.0KJ$ then ΔS will be

A. $22JK^{-1}mol^{-1}$

B. $35JK^{-1}mol^{-1}$

C. $48JK^{-1}mol^{-1}$

D. $100JK^{-1}mol^{-1}$

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113. Melting & boiling point of NaCl respectively are 1080 K & 1600K. ΔS for stage -I & II in $NaCl_{(s)} \overset{I}{\rightarrow} \Delta H_{\text{fus}} = 30kJ NaCl_{(l)} \overset{II}{\rightarrow} \Delta H_{\text{vap}} = 160kJ$ are

A. $\begin{array}{ll} \Delta S(I) & \Delta S(II) \\ 1/36(KJ/mol/K) & 1/10(KJ/mol/K) \end{array}$

B. $\begin{array}{ll} \Delta S(I) & \Delta S(II) \\ 36(KJ/mol/K) & 100(KJ/mol/K) \end{array}$

C. $\begin{array}{ll} \Delta S(I) & \Delta S(II) \\ 1/36(KJ/mol/K) & 10(KJ/mol/K) \end{array}$

D. $\begin{array}{ll} \Delta S(I) & \Delta S(II) \\ 36(KJ/mol/K) & 1/10(KJ/mol/K) \end{array}$

Answer: A

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114. At 300K, heat of dissociation of lime stone is $+180kJmol^{-1}$. Entropies of $CaCO_3, CaO$ and Co_2 are respectively $93, 39$ and $213Jmol^{-1}K^{-1}$. Calculate ΔS_{total}

A. -441

B. $+441$

C. $+882$

D. -220.5

Answer: A

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115. In the conversion of lime stone to lime, $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$, the values of ΔH° and ΔS° are + 179.1 kJ mol^{-1} and 160.2 $JK^{-1}mol^{-1}$ respectively at 298K and 1 bar. Assuming, ΔH° and ΔS° do not change with temperature, temperature above which conversion of lime stone to lime will be spontaneous is

A. $+2734$

B. -2734

C. -2984

D. -838

Answer: B

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116. For an isothermal reversible phase transition process , ΔS is

A. $T/\Delta H$

B. $T.\ \Delta H$

C. $\Delta H/T$

D. $\int_o^T \frac{C_P}{T} dT$

Answer: C

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117. The thermodynamic property that measures the extent of molecular disorder is called entropy. The direction of a spontaneous process for which the energy is constant is always the one that increases the molecular disorder. Entropy change of phase transformation can be calculated using Trouton's formula $\left(\Delta S = \frac{\Delta H}{T}\right)$. In the reversible adiabatic process, however, ΔS will be zero. The rise in temperature in isobaric and isochoric conditions is found to increase the randomness or entropy of the system. $\Delta S = 2.303C\log\left(T_1/T_2\right), \left(C = C_P \text{ or } C_V\right)$

The melting point of a solid is 300K and its latent heat of fusion is 600 cal mol^{-1}. The entropy change for the fusion of 1 mole of the soli (in cal K^{-1}) at the same temperature would be:

A. 200

B. 2

C. 0.2

D. 20

Answer: B

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118. Which of the following reaction is spontaneous at room temperature

A. ΔH and ΔG should be negative

B. Only ΔHshould be negative

C. ΔH and ΔG should b e positive

D. Only ΔG should be positive

Answer: B

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119. One mole of ice is converted into water at 273 K. The entropies of $H_2O_{(s)}$ and $H_2O_{(l)}$ are 38.20 and $60.01 Jmol^{-1}K^{-1}$ respectively. The enthalpy change for the conversion is

A. $59.54 Jmol^{-1}$

B. $5954 Jmol^{-1}$

C. $595.4 Jmol^{-1}$

D. $320.6 Jmol^{-1}$

Answer: B

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OBJECTIVE EXERCISE-3

1. Ionisation of energy of F^{-} is $320 kJmol^{-1}$. The electron gain enthalpy of fluorine would be

A. $-358.5 kJmol^{-1}$

B. $-508.9 kJmol^{-1}$

C. $-208.1 kJmol^{-1}$

D. $-269.9 kJmol^{-1}$

Answer: D

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2. For the reaction, $Ag_2O_{(s)} \Leftrightarrow 2Ag_{(s)} + \frac{1}{2}O_{2(g)}\Delta H, \Delta S$ and T are 40.63 kJ $mol^{-1}, 108.8JK^{-1}mol^{-1}$ and $373K$ respectively. Free energy change ΔG of the reaction will be _____

A. 300 K

B. $285.7K$

C. $273K$

D. $450K$

Answer: B

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3. Assume each reaction is carried out in an open container. For which reaction will $\Delta H = \Delta E$?

A. $2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$

B. $H_{2(g)} + Br_{2(g)} \rightarrow 2HBr_{(g)}$

C. $C_{(s)} + H_2O_{(g)} \rightarrow 2H_{2(g)} + CO_{2(g)}$

D. $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

Answer: B

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4. Identify the incorrect statement with reference to Bentham and Hookers system

A. If $\Delta G_{\text{system}} < 0,$ the process is not spontaneous,

B. $If \Delta G_{\text{system}} > 0,$ the process is not spontaneous.

C. $If \Delta G_{\text{system}} = 0,$ the system has attained equilibrium

D. If $\Delta G_{\text{system}} = 0,$ the system is still moving in a particular direction.

Answer: C

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5. Heats of atomisation of chlorine and hydrogen are $243kJmol^{-1}$ and $435kJmol^{-1}$ respectively. Heat of formation of HCl is $-92kJmol^{-1}$. Calculate the bond energy of HCL.

A. $380kJmol^{-1}$

B. $425kJmol^{-1}$

C. $245kJmol^{-1}$

D. $290kJmol^{-1}$

Answer: B

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6. Which is the following are not state functions ?

i)$q + w$

ii) v

iii) w

iv) H-TS

A. I, ii and iii

B. iiand iii

C. I and iv

D. ii,iii and iv

Answer: B

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7. For the reaction $PCl_{5(g)} \leftrightarrow PCl_{3(g)} + Cl_{2(g)}$. Which of the graph is/are correct?

A. $\Delta H < 0$ and $\Delta S < 0$

B. $\Delta H > 0$ and $\Delta S < 0$

C. $\Delta H = 0$ and $\Delta S < 0$

D. $\Delta H > 0$ and $\Delta S > 0$

Answer: D

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8. The bond dissociation energies for Cl_2, I_2 and Icl are 242.3, 151 and 211.3 kJ/mol respectively. The enthalpy of sublimation of iodine is 62.8 kJ/mol. What is the standard enthalpy of formation of $ICl_{(s)}$?

A. $-93kJmol^{-1}$

B. $245kJmol^{-1}$

C. $93kJmol^{-1}$

D. $-245kJmol^{-1}$

Answer: A

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9. The value of $\Delta H - \Delta U$ for the following reaction at $27^\circ C$ will be : $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

A. 910 K

B. 1110 K

C. 510 K

D. 710 K

Answer: B

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10. The following two reactions are known

$Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2(g)}, \Delta H = -26.8 kJ/mol$

$FeO_{(s)} + CO_{(g)} \rightarrow Fe_{(s)} + CO_{2(g)}, \Delta H = -16.5 kJ/mol$

The value of ΔH for the following reaction

$Fe_2O_{3(s)} + CO_{(g)} \rightarrow 2Feo_{(s)} + CO_{2(g)}$ is

A. $+10.3 kJ/mol$

B. $-43.3 kJ/mol$

C. $-10.3 kJ/mol$

D. $+6.2kJ/mol$

Answer: D

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11. In the reaction $N_{2(g)}+O_{2(g)} \Leftrightarrow 2NO_{(g)}, \Delta H$ = + 180 kJ On increasing the temperature the production of NO

A. 750 K

B. 1000K

C. 1250K

D. 500K

Answer: B

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12. Two moles of an ideal gas is expanded spontaneously into a vacuum. The work done is

A. infinite

B. 3 Joules

C. 9 Joules

D. zero

Answer: D

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13. For an endothermic reaction energy of activation is E_a and enthalpy of reaction is ΔH (both in kJ mol^{-1}) Minimum value of E_a will be

A. less than ΔH

B. equal to ΔH

C. more than ΔH

D. equal to zero

Answer: C

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14. Consider the following process :

$$\frac{1}{2}A \rightarrow B \qquad \Delta H = +150(kJ/mol)$$

$$3B \rightarrow 2C + D \qquad \Delta H = -125(kJ/mol)$$

$$E + A \rightarrow 2D \qquad \Delta H = +350(kJ/mol)$$

For $B + D \rightarrow E + 2C$, ΔH will be

A. 525 kJ/mol

B. -175 kJ/mol

C. -325 kJ/mol

D. 325 kJ/mol

Answer: B

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15. Ionisation of energy of F^- is $320kJmol^{-1}$. The electron gain enthalpy of fluorine would be

A. $10Jmol^{-1}K^{-1}$

B. $1.0Jmol^{-1}K^{-1}$

C. $0.1Jmol^{-1}K^{-1}$

D. $100Jmol^{-1}J^{-1}$

Answer: D

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16. The enthalpy change for the reaction $C_2H_{6(g)} \rightarrow 2C_{(g)} + 6H_{(g)}$ is x kJ. The bond energy of C-H bond is:

A. $-434.8kJ$

B. $-869.6kJ$

C. $+434.8kJ$

D. $+217.4kJ$

Answer: C

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17. Latent heat of fusion of ice is $6kJmol^{-1}$. Calculate the entropy change in the fusion of ice.

A. 10.52 cal/(mol K)

B. 21.04 cal(molK)

C. 5.260 cal/(mol K)

D. 0.526 cal (mol K)

Answer: C

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18. The standard molar engthalpy of vaporisation of benzene $\Delta_{vap}H^{\circ}$ at 353 K is 30.8 kJ mol^{-1}.

If the benzene vapours behave as an ideal gas, the change in internal energy of vaporisation of 78 g of benzene at 353 K in kJ mol^{-1} is

A. $+37.56$

B. -43.76

C. $+43.76$

D. $+40.66$

Answer: A

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19. When 5 litres of a gas mixture of methane and propane is perfectly combusted at $0^{\circ}C$ and 1 atmpsphere, 16 litres of oxygen at the same temperature and pressure is consumed. The amount of heat released from this combustion in $kJ\left(\Delta H_{comb.}\right)\left(CH_4\right) = 890kJmol^{-1}$,

$\Delta H_{comb.}\left(C_3H_8\right) = 2220kJmol^{-1}\big)$

A. 38

B. 317

C. 477

D. 32

Answer: B

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20. A reaction having equal energies of activation for toward and reverse reaction has

A. $\Delta H = 0$

B. $\Delta H = \Delta G = \Delta S = 0$

C. $\Delta S = 0$

D. $\Delta G = 0$

Answer: A

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21. From the following data

$$CH_3OH(l) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

$$\Delta_r H^\circ = -726 kJmol^{-1}$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l), \Delta_r H^\circ = -286 kJmol^{-1}$$

$$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g), \Delta_r H^\circ = -393 kJmol^{-1}$$

The standard enthalpy of formation of $CH_3OH(l)$ in $kJmol^{-1}$ is

A. $z = x + y$

B. $x = y + z$

C. $y = 2z - x$

D. $x = y - z$

Answer: B

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22. For the reaction $X_2O_{4(l)} \rightarrow 2XO_{2(g)}, \Delta U = 2.1\text{kcal}, \Delta S = 20\text{cal } K^{-1}$ at 300K, Hence ΔG is

A. 2.7 kcal

B. -2.7 kcal

C. 9.3 kcal

D. -9.3 kcal

Answer: B

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23. Which of the following statements is correct

A. ΔS is negative and therefore ΔH should be highly positive.

B. ΔS is negative and therefore, ΔH should be highly negative.

C. ΔS is positive and therefore ΔH should be negative.

D. ΔS is positive and therefore, ΔH should also be highly positive

Answer: B

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24. Enthalpy of combustion of carbon to CO_2 is $-393.5 kJmol^{-1}$. Calculate the heat released upon formation of 35.2 g of CO_2 from carbon and dioxygen gas.

A. $+315kJ$

B. $-630kJ$

C. $-3.15kJ$

D. $-315kJ$

Answer: A

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25. A sample of an ideal gas with initial pressure 'P' and volume 'V' is taken through an isothermal process during which entropy change is found to be DS. The work done by the gas is

A. $\Delta S = nR\ln\left(\frac{p_f}{P_i}\right)$

B. $\Delta S = nR\ln\left(\frac{p_i}{P_f}\right)$

C. $\Delta S = nRT\ln\left(\frac{p_f}{P_i}\right)$

D. $\Delta S = nRT\ln\left(\frac{p_i}{P_f}\right)$

Answer: B

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26. The correct thermodynamic conditions for the spontaneous reaction at all temperatures is

A. $\Delta H < 0$ and $\Delta S < 0$

B. $\Delta H > 0$ and $\Delta S < 0$

C. $\Delta H < 0$ and $\Delta S > 0$

D. $\Delta H < 0$ and $\Delta S < 0$

Answer: C

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27. A gas absorbs 100 J of heat and is simultaneously compressed by a constant external pressure of 1.5 atm from a volume of 8.0L to 2.0L. The change in internal energy for the gas in Joules is (1L - atm = 101.32 J))

A. $+505J$

B. $113625J$

C. - $500J$

D. - $505J$

Answer: D

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28. In the conversion of lime stone to lime, $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$, the values of ΔH° and ΔS° are + 179.1 kJ mol^{-1} and 160.2 $JK^{-1}mol^{-1}$ respectively at 298K and 1 bar. Assuming, ΔH° and ΔS° do not change with temperature, temperature above which conversion of lime stone to lime will be spontaneous is

A. $T > 298K$

B. $T < 425K$

C. $T = 425K$

D. All Temperature

Answer: C

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